THE DISSECTION OF

THE RABBIT

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PREFACE

THIS book has been prepared in accordance with the plan outlined in the companion volume *The Dissection of the Frog*, the success of which has convinced us that there is a real need for books of this kind.

The same general plan has been followed, the fullest possible details of methods of dissection being given so that the student who conscientiously works through them and does the relevant reading suggested in the Preparation will obtain a very thorough knowledge of the anatomy of a mammal as typified in the Rabbit. This we are convinced will render more valuable and more readily understandable any theoretical considerations which may be dealt with in other parts of the student's work.

In an animal like the rabbit, from considerations of convenience, it is not always possible to follow the usual procedure of dealing exclusively with one system at a time. Consequently the method of treatment has been generally to deal with regions, and the sequence of the work has been planned on these lines. However, this does not preclude the possibility of modification to suit individual tastes on the part of the teacher or the student, since the account of each piece of work is complete in itself.

We are grateful to Mr. Robert Walton for the photographs (from his own dissections) reproduced in this book.

R. H. W.
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Laboratory Method

The system of instruction usually followed in colleges and schools consists of lectures combined with practical work. Most, one may say all, junior students—very often seniors too—find it none too easy to get full benefit from lectures, for strictly speaking, lectures of the serious type are of full benefit only to those who already know a great deal about the subject of the lectures. It is certain that you will miss a great deal of what you are told in lectures, for very few can listen to one thing and write another at the same time; thus you will have to depend on your reading and laboratory work to clear up things.

Do not go to the laboratory without having first prepared yourself in the work to be done. Go through your lecture notes and that part of your textbook concerned, as recommended in the Preparation section of this book. It is also advisable to read through the laboratory instructions so that you will be able to follow them more quickly when actually engaged in your practical work.

If you meet with any difficulty at all, do not fail to make a note of it and get it cleared up in the laboratory. One of the chief complaints about students' work which every demonstrator makes is that students will not ask questions. But, remember, do not ask questions the answers to which can be found very easily by consulting your textbook; get into the habit of searching books for references. Do not look upon your demonstrator as a labour-saving machine or an encyclopaedia.

Now the demonstrator will not merely come round the laboratory and ask " Is everything clear ? " or " Is there any difficulty ? " and pass on when ninety-nine times out of a hundred the answer invites no attention. He will sit down beside you at your work, see what you have done and how you have done it; he will examine your drawings and note particularly your labelling and your

laboratory notes; he will question you on the subject of your work, and will put you right where you are wrong, or he will suggest improvements. He will answer your questions, and as he leaves you will tell you what he expects done by the time he next gets round to you. It is your business to make the most of his presence.

The laboratory is a workshop, and it is to your advantage to go on quietly with your work and make as much use of your opportunities as possible. Never leave the laboratory without getting every scrap of your records checked; the error in an incorrect entry is impressed on your mind every time you see it, but if your records are reliable, they are invaluable for revision and general study.

Your Tools

The choice of instruments is a matter of individual taste and the result of experience. The suggestions below, however, are recommended as a minimum.

1. One pair of large straight dissecting scissors with about 2 in. blade.

2. One pair of fine straight scissors with 1¼ in. blade. [*The scissors in which the halves can be separated are excellent, and can be more easily kept clean.*]

3. One large all-metal scalpel, 2 in. blade.

4. One medium all-metal scalpel, 1 in. blade.

5. One fine all-metal scalpel with narrow blade like a cataract knife.

6. One all-metal seeker of which the end must be rounded, not truncated or sharp. [*All-metal scalpels and seekers are recommended in preference to those with wooden handles, as the latter, sooner or later, break at the rivets.*]

7. Two mounted needles. [*Holders with a chuck can be purchased quite cheaply.*]

8. One pair of strong blunt forceps, preferably of stainless steel, 5 in. long.

9. One pair of medium fine point forceps, preferably stainless steel, about 4 in. long.

10. One pair of very fine point forceps, preferably stainless steel or heavily nickelled, with almost needle points. [*When purchasing see that the points meet exactly, and that they do not overlap when closed.*]

11. One aluminium section lifter.

12. One camel hair or sable brush.

13. One pipette.

14. One pair of dividers for measuring.

15. One small steel rule.

16. One watchmaker's eyeglass, or mounted lens.

It is always desirable to have a duplicate set of scalpels, so that if one is dulled a sharp one is immediately available to continue dissection.

The most convenient case for instruments is a strip of baize or canvas with each of the long sides folded over as a loose flap, and a length of tape along the middle sewn down at about half-inch intervals. The finished article should be about seven inches wide and twelve to eighteen inches long, with a wrapping tape at one end.
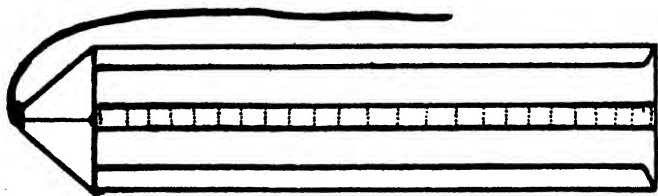
This type of case has the advantage that additional instruments can be accommodated. The box type has very limited accommodation, and scalpels and scissors other than those supplied with the box rarely fit; it is also more costly.

Care of Instruments

Take the greatest care of your instruments and " neither a borrower nor a lender be."

Good dissection is quite impossible with dirty or blunt instruments. Use them *only* for the work for which they are intended. Here are a few hints:

1. Cut nothing but tissue with scalpels or scissors. (Use a pocket knife for sharpening pencils.)

2. Keep a special large scalpel for " rough " work, such as for cutting the skin of dogfish or for scraping.

3. Do not stick mounted needles by their points in the bench or dissecting board.

4. Carefully wipe all instruments dry after use, giving special attention to scissors round the rivet. (It is quite the best thing to wipe over cleaned instruments with an oiled rag.)

Sharpening of Scalpels and Scissors

Unless cutting instruments are in perfect condition, good dissection is impossible; blunt instruments are responsible for most " accidents " in dissecting, and it always pays to keep scalpels and scissors really sharp.

The secret of keeping scalpels and scissors in perfect condition is never to let them become badly dulled. Men strop razors every time after use because they know that a clean and comfortable shave is impossible with even a slightly dulled razor. Scalpels should be kept continually as sharp as a good razor. It is well worth practising until you are successful at sharpening scalpels on an oil stone.

With just a spot of oil on the stone, give a circular motion to the scalpel, holding it perfectly rigid and almost flat on the stone. Do this quite lightly and give only two or three rubs on each side alternately. Turn the scalpel over on its back, never on its edge—just as you would a razor.

The real test of sharpness is, of course, cutting cleanly, but if the edge of the scalpel can be seen edge-on with a lens, it is dull and needs sharpening.

Never let a scalpel get really dulled, and get into the habit of always examining the edge before use. If it is only slightly dull, a few seconds with the oil stone is quite sufficient, for it is usually only the tip that needs attention.

Scissors are, for most people, more difficult to sharpen, and it is usual, and perhaps advisable, to take them to an instrument maker for sharpening. However, with some practice, they are easy to keep in condition. Examine the angle of the cutting edge; then hold the blade on the stone in such a way as to preserve that angle—a variation from it will ruin the scissors. Keeping the blade absolutely fixed at the proper angle, take it along the stone in one direction only, away from you. Finish by putting the blade face down and flat on the stone to take off any burring of the edge. Special attention should be given to the points.

One word of warning regarding the oil stone: for scalpels, do not use the stone which is reserved for sharpening razors, because hollows will be worn in it and make it unfit for sharpening razors.

Drawings

Diagrams are intended to be a part of the record of your work, and if faithful they are invaluable for future reference. It is extremely foolish to copy textbook diagrams in place of original drawings from the specimen; by doing so you gain *nothing*, but lose one of the most valuable parts of your training. Every examiner in practical biology finds that the majority of sketches given in practical tests are merely recollected textbook diagrams, and assesses them at their true value—O. A faithful diagram is at once appreciated by an examiner.

It is most important that students should realise that it is *diagrams* that are wanted, not attempts at pictures. Your diagram must be a graphic record of what another can find in the dissection; if it is not, it is valueless. And in order that the record may be readily interpreted, the topography needs to be given. This means that other structures than those specially to be illustrated should be indicated; for example, where the course of nerves is to be shown, neighbouring muscles or blood vessels which are useful as landmarks should be indicated. In the case of a

diagram of the vascular system, a copy of the stereotyped textbook figure is quite useless as a record of practical work.

In your own interest, therefore, scrupulously avoid copying textbook figures. When a specimen shows a variation from the normal, it would be fortunate for you in an examination if your drawing showed this with a note pointing out the abnormality.

All diagrams should be drawn in pencil, and colouring should rarely be used; really neat lines cannot be made with coloured crayons, but the chief objection is that errors in crayon cannot be corrected effectively. Black and white drawings are much neater. On rare occasions a slight amount of colouring might be an advantage, *e.g.* when several nerves and blood vessels run closely parallel, neat colouring of the vessels might be done *after* checking.

Wherever possible, draw the diagram of a system inside an outline of the body; this greatly assists correct proportion, and indicates the exact course taken by vessels, nerves, etc.

Avoid, wherever practicable, double lines to represent nerves, vessels, etc. They are usually unnecessary, are difficult to do neatly, and take more than double the time required for single lines.

Label your figures fully. Do this in very neat handwriting or in lettering, and write all names *horizontally*. Indication lines should go from the name *exactly* to the spot labelled, so that there can be no ambiguity; these lines should also be of such a nature as to be distinct from lines in the drawing; a short-dash line is perhaps the best; they should not cross.

Laboratory Notes

If your work is to be a training in scientific method, you must adopt the system of working characteristic of the investigator. After studying the results of previous investigators, he repeats their experiments with a view to verification, and in the course of his work makes diagrams *and* at every step keeps a written record of his observations.

There are often points which a diagram alone cannot show; there are difficulties to be reminded of in the future; there are methods of preparation and dissection; there are variations to be noted; and so on.

Thus a laboratory book should not be regarded merely as a book of diagrams; it must be a complete record of your work, and laboratory notes are quite as important as a record as are diagrams and labels. Further, for revision work, notes are invaluable.

Here is an illustration of a laboratory note, given as a guide to what is expected—

HAIR. Covering of the body—mammalian feature. Specialised hairs as eyelashes and vibrissae.

Function: To conserve warmth; to protect the skin. Specialised hairs have special functions, *e.g.* protection of the eyes, or tactile sensory structures.

Colour: Protective in the wild rabbit, varied in the domesticated owing to artificial selection.

White patch on under side of tail in the wild rabbit; alarm signal?

The Use of a Dissecting Lens

You are advised to use constantly a watchmaker's eyeglass; this is preferable to a hand lens, since both hands are left free for dissection. And since it is possible that you have had little or no experience of the use of a watchmaker's eyeglass, you should practise holding one in position and continue to do so until you can safely lodge it without fear of its falling. Another important point is that you should use the glass with *both* eyes fully open; this will be easily possible with practice, just as it is in the case of a microscope; to screw up the eye which is not in use is very tiring and even injurious. For skilful dissection on a small animal, such an aid as a watchmaker's eyeglass is almost indispensable.

THE DISSECTION OF THE RABBIT

SECTION I

PREPARATION FOR LABORATORY WORK

You are strongly advised to read, before undertaking practical work, as much of the anatomy and physiology of the rabbit as you will have to study in the laboratory. To attend the laboratory without having at first a fair idea of what you are expected to display in dissection will result in mistakes and much slower progress.

Your reading should include as much as possible of that part of your study which is connected with your practical work; *e.g.* though you will not be able to study digestion in the laboratory, you should read about it before dissecting the alimentary canal. In this way, your laboratory work will be much more intelligible and interesting.

Three commonly used textbooks have been chosen from which to offer you a guide to such reading. They are

(1) *Textbook of Zoology*, by Wells and Davies, University Tutorial Press, 1929 edition. This book is referred to under W. and D.

(2) *Manual of Zoology*, by Borradaile, Oxford University Press, 1941, *Tenth Edition*. This book is referred to under B.

(3) *Biology for Medical Students*, by Hentschel and Cook, Longmans, Green and Co., 1939. This book is referred to under H. and C.

In addition, *The Science of Life*, by H. G. Wells, J. Huxley, and G. P. Wells, is strongly recommended to all biology students.

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Skull of Dog and Rabbit

W. and D.   Study pp. 91 to 97; paras. 15-20, and Figs. 46 to 50.   In Fig. 49, the lower part of the bone which is labelled *parietal* is really *squamosal*.

B.   Study pp. 488 to 494 (top), and Figs. 376-380, 421 (p. 538) and 422 (p. 539).   The accounts given here apply chiefly to the rabbit.   On p. 491, l. 11 the *vomer* is described as a pair of bones fused together: most authorities now regard the vomer as a single median bone representing the anterior part of the parasphenoid of a frog and not the paired vomers in that animal which are regarded as pre-vomers.

H. and C.   Study pp. 271 to 279, and Figs. 135 to 139.

Vertebral Column

W. and D.   Study pp. 80 to 85; paras. 2 to 8, and Figs. 29 to 36.

B.   Study pp. 482 to 488 (top), and Figs. 372 to 375.

H. and C.   Study pp. 267 to 270, and Figs. 132 to 134. Those (8 and 9) which are attached by cartilages to the last sternal rib are termed *false* ribs, and those (10-12) with no attachment to the sternum at all, *floating* ribs. The floating ribs have no tuberculum, but the true and false ribs have.

The cartilaginous plate at the posterior end of the sternum is often called the xiphoid cartilage or xiphisternal cartilage, the name xiphisternum being reserved for the bony shaft.

Pectoral Girdle

W. and D.   Study pp. 85 to 87; paras. 9 and 10, and Figs. 37 to 39.

B.   See p. 494 (middle).

H. and C.   See p. 279 and Fig. 140.

Fore Limb

W. and D.   Study pp. 87 to 89; para. 11, and Figs. 40 and 41.

B.   Read pp. 494 (bottom line) to 497 (top), and Figs. 374, 375, 383, and 384 A.

H. and C.   Study pp. 279 (bottom) to 281 (top), and Figs. 141 and 142.

Pelvic Girdle

W. and D.   Study pp. 89 to 90; para. 12, and Figs. 42 and 43.   Refer also to para. 9, p. 85.

B.   Study p. 494 (bottom) and Fig. 382.

H. and C.   Study pp. 281 (bottom) to 283 (top), and Fig. 144.

Hind Limb

W. and D.   Study pp. 90 and 91; paras. 13 and 14, and Figs. 44 and 45.   These authors adopt the view that the distal tarsale I is fused to metatarsale II.

B.   Study p. 497, l, 4, and Figs. 372, 374 D, and 384 B.

H. and C.   Study p. 283, and Figs. 143, 145, and 146.

External Features

HAIR.   W. and D.   Read p. 3, section 4, and p. 63, section 4.   The first reference deals with hair in general terms and the second with the structure of hair and other epidermal structures.   Study the figure on p. 64 till you can reproduce a diagram showing those features in the figure.   Note that the whole of the hair follicle is epidermal. It would have been better had the figure shown the malpighian layer extending round the base of the follicle, including the sebaceous glands.   Note also that a muscle is attached to the base of the follicle by which movement of the hair may be effected.

B. Study p. 480. Note the remark about the hair-like outgrowths found among the invertebrates. Study Fig. 370 till you can reproduce from memory the parts shown. Note the sebaceous gland.

H. and C. Read the whole of the section on the exoskeleton and skin, pp. 229 to 232, and in particular the third paragraph (pp. 230 to 231). Study Fig. 113 till you can reproduce from memory all the parts shown.

NOSTRILS. Remember that the nostrils function as an inlet both to the respiratory system and to the olfactory organs for smelling. Obviously it is convenient to have the olfactory organ in the current of inbreathed air. Recall your study of the skull and that the respiratory current is above the roof of the mouth. Remember the ethmoturbinal bones and the vast surface on them capable of responding to odoriferous particles in the air. By continually sniffing, the rabbit rapidly changes the air among the turbinals, to be replaced by fresh incoming scent-laden air; little of such interchange occurs during the simple respiratory action, unaccompanied by sniffing.

Read what you can of the sense of smell to get a general idea of this sense, so very important to such animals as the rabbit, dog, and most other mammals. You should be ready to compare the efficiency of the olfactory sense in the rabbit with that in the other vertebrates you study, *e.g.* the frog and the dogfish.

W. and D. Read p. 126, section 4, for details of the interior of the olfactory organs. Consult Fig. 1, p. 2, to understand the associations between nostrils, nasal chamber and pharynx. Note where the turbinals would be in this figure. The connection between the orbit and the nasal chamber by the lacrimal duct (nasal duct) is referred to on p. 133, end of section 11.

B. See p. 478, l. 10, for a reference comparing the nostrils with those of the dogfish and the frog. Refer to Fig. 385, p. 499. The ethmo-turbinals are indicated in the

upper part of the nasal chamber, and the nasal passage above the roof of the soft palate. Read the legend under the figure.

Study the second half of p. 498 for the internal anatomy. Note the reference to the lacrimal duct (nasal duct) under " Sense Organs," p. 522.

H. and C. Read p. 265, first paragraph under " Organs of Special Sense" for internal anatomy. The lacrimal duct (nasal duct) from the eye to the nasal chamber is referred to in paragraph 3. Refer to Fig. 114, p. 233, for relations between the pharynx and respiratory channel. Note the position of the turbinals.

INCISOR TEETH. W. and D. Study p. 15, section 6, and p. 61, top paragraph, where continuous growth is explained. But note that other authors (cf. Borradaile) give the same characteristic to all the teeth.

B. See p. 500. In regard to continuous growth of the teeth, note that other authors (cf. Wells and Davies) endow only the incisor teeth with this characteristic.

H. and C. See p. 235 and reference to persistent pulps on p. 236. It is implied that only the incisors have persistent pulps. (See above.)

THE EYE. By first studying the structure of the whole eye, you will appreciate the nature and significance of the parts externally visible. Do not omit to study the muscles of the eyeball and also the mechanism for accommodation.

W. and D. Study pp. 129 to 133, sections 8 to 11, which deal with the structure of the eye and its associated muscles and glands. Fig. 64, p. 130, shows a "yellow spot," but no reference to it seems to be made in the text. In this connection it is interesting to note that in *The Science of Life* (Wells, Huxley, and Wells), p. 79, the authors seem to suggest that the yellow spot is found only in man, apes, and monkeys, which possession endows these creatures

with much clearer vision than other mammals. However, textbooks of zoology often refer to the presence of a yellow spot in " the vertebrate eye." It should be noted that at the yellow spot, which is opposite the lens, the layer of nerve fibres is reduced, thus, at this point, offering less hindrance to the formation of a sharp image than elsewhere on the retina.

B. On p. 478 the eyelids are referred to among the external features. On p. 533 tear glands (or lacrimal glands) are dealt with. [Note—the nasal duct is sometimes called the lacrimal duct.] It is expected that you refer to the eye of the frog on p. 90, where the structure is given in some detail. No reference is made to the blind spot or yellow spot. In Fig. 49, p. 89, the entrance of the optic nerve (at the blind spot) is placed immediately opposite the pupil; this is unusual, since the blind spot is to one side of the central axis; were it not so, the sharpest image would be on the blind spot ! Where a yellow spot is present, it is immediately opposite the pupil. [See note above, under W. and D.]

H. and C. See p. 265 (middle). As regards structure, you are expected to refer to pp. 131-134 (under dogfish) where a full description is given of the vertebrate eye. Note: the retractor bulbi is a muscle (in the frog) which is alongside the optic nerve, and which produces a backward and forward motion to the eyeball. The lacrimal duct is sometimes called the nasal duct. Fig. 66, p. 132, is worth studying. Note the position of the blind spot and the yellow spot. [See note above, under W. and D.]

THE EAR. Read what you can of the structure of the ear. [*The Science of Life* gives a most interesting description.] Note the two-fold function of the ear—an organ of hearing and of balancing. Try and get an idea of the relative position of the parts. Compare the parts of the ear in the dogfish, frog, and rabbit, and note that the cochlea is characteristic of mammals.

W. and D.   Study pp. 127 to 129, sections 5, 6, and 7.
Under section 6 note the meaning attached to the " drum "
of the ear, viz. the equivalent of the tympanic cavity.
More commonly the " drum " is synonymous with " tym-
panic membrane."   In general it would be better to avoid
the word " drum " unless you make it quite clear what you
mean by the term.

B.   On p. 522, under " Sense Organs," reference is
made to the cochlea and you are referred to pp. 489 and
491 which deal with the bony parts of the ear.   See Fig.
402, p. 521, for the arrangements in the middle ear; but
the position of the tympanic bulla is not shown.   Note
that the author uses the terms " drum " and " tympanic
membrane " as synonymous; see note above.

H. and C.   Read under "Organs of Special Sense,"
pp. 265 and 266, referring to Fig. 131 for the relation of
parts.   Note that here "drum" and "tympanic mem-
brane" are synonymous; see note above under W. and D.

MAMMARY GLANDS.   W. and D.   Read p. 139, section 7.
Note the suggestion that the glands are related to the
sebaceous glands.

B.   See p. 478 for a short reference to the presence of
teats.

H. and C.   See pp. 228 (bottom) to 229.   On p. 231 is a
good description of the glands and their physiology.   Their
probable relation to sebaceous glands is mentioned.   See
Fig. 105, p. 216, for malpighian layer.

PERINEAL POUCHES.   W. and D.   Read p. 139, para. 6.
Note that the rectal gland is said to have a similar
function.   See Fig. 67, p. 138, for the position of the gland.

B.   See p. 478 (l. 14 from bottom).   See also Fig. 392,
p. 509, for the position of the gland, and Fig. 391, p. 508,
for natural position.

H. and C.   P. 229.   The perineal pouch is called the
perinaeum.

URINO-GENITAL APERTURES. W. and D. Read pp. 135 to 139 under " Reproduction."

B. See p. 478 about middle of page.

H. and C. See p. 229 and Figs. 126 and 127, pp. 256 and 257.

THE LIMBS. W. and D. See p. 3. Pentadactyl means five-digited. " The great majority " refers to animals above fishes which possess limbs. Also see first paragraph of section 11, p. 87, which explains prone and supine positions.

B. See bottom p. 478, which explains the position of the fore limbs in progression. Prone and supine positions are also explained on p. 495.

H. and C. See p. 228, for a reference to the position of limbs compared with other animals.

The Thoracic Wall

W. and D. See p. 82, section 4. Note the reference to the occasional presence of a 13th rib (floating rib). The sternum is referred to as consisting of manubrium, five sternebrae and a xiphisternum.

B. Study pp. 485 to 488. Consult Fig. 372, p. 483, Fig. 374 B, p. 486, and Fig. 375, p. 487. Note that in Fig. 375 ·the manubrium is regarded as the first sternebra. Xiphoid process is given as an alternative name for xiphisternum and xiphoid cartilage for xiphisternal cartilage.

H. and C. See p. 256. In the earlier editions the meaning attached to "false" and "floating" ribs was unusual: "false" and "floating" were regarded as synonymous, but as a rule they are considered distinctive. Nos. 8 and 9 are "false" because of their indirect connection with the sternum by means of the 7th rib. Nos. 10, 11 and 12 are "floating" because of the absence of any connection with the sternum, direct or indirect.

See Fig. 133, p. 270, and note that some authors use " xiphisternum " for what other authors call " xiphisternal cartilage." Xiphisternum usually refers to the bone between the xiphisternal cartilage and the 7th rib.

Viscera. Alimentary Canal

Before the actual dissection, it is advisable to study the digestive processes in, and the structure of, the various parts of the alimentary canal. Read your textbooks to find out (1) what the body needs; (2) what food contains; (3) what happens to the food at various stages along the alimentary canal; (4) how the parts of the alimentary canal are, by their structure, able to accomplish (*a*) the breaking up of the food into its constituent parts, (*b*) the extraction of food material, and (*c*) the expulsion of waste.

W. and D. Study pp. 7 to 10, sections 11 to 16; the whole of Chap. II., pp. 12 to 22; p. 26, section 7. Consult Fig. 4, p. 28. Read also p. 29, section 9, and p. 34, section 15. Study pp. 67 to 75, sections 8 to 13. See Fig. 1, p. 2 for a conventionalised disposition of the viscera.

B. Read p. 7, bottom paragraph to middle of p. 10. For structure of the gut wall, you need to study that in the frog—similar in essentials—as no special reference to the rabbit is made in this respect. Read pp. 500 (Salivary Glands) to 505 (top). Fig. 386, p. 501 shows the viscera, " the organs being somewhat displaced so as to display them." The displacement has been sufficient to destroy the original oblique disposition of the colon and caecum. Cf. Fig. 32 of this book.

There is no figure showing the vascular supply of the gut.
H. and C. Study pp. 236 (bottom) to 239, and the section on digestion, pp. 239 to 241. Study "Glandular Epithelium," pp. 199 to 202; and "Unstriped Muscle," pp. 214 to 215.
Regarding the vascular supply of the gut, see the text,

bottom p. 245 and overleaf for arteries, and bottom p. 248 for the hepatic portal system of veins. Unfortunately no figure is given. Note that only the posterior part of the rectum is served by the posterior mesenteric artery and vein.

The Spleen

W. and D. See p. 36. Brief reference is made along with the thymus and the tonsils. Note the suggested function—manufacture of white blood cells. See also p. 63 (top) which deals with a second function regarding red blood cells.

B. See p. 505, where there is a short reference under " Ductless Glands." Reference to its function in the frog is made on p. 60.

H. and C. Read p. 249 (middle). Interesting remarks are made on possible functions.

The Solar Plexus

You should read what is given in your textbooks concerning the sympathetic system in general.

W. and D. Study pp. 112 to 113, section 4.

B. See p. 521. The ganglia are referred to as coeliac ganglia only; other authors differentiate them into coeliac and anterior mesenteric ganglia. See Fig. 401, p. 520, for position and connections.

H. and C. Study pp. 264 (middle) to 265. A fairly full description is given.

The Gonads

In this preparation stage, it would be advisable to read all that your textbooks say regarding all the reproductive organs. By understanding the structure and function of the various parts, your dissection will be more intelligible. Note that " Gonad " refers to either the ovary or the testis.

W. and D.   Read Chap. XI., sections 1 to 5 inclusive. Study the diagrams, Figs. 66 and 67, carefully, so that you can reproduce them from memory.

B.   The reproductive organs are considered along with the excretory organs with which there are always associations in the vertebrate.   Read pp. 506 to 510.   The reasons for the connection with the excretory organs are explained. The comparison of these organs in the dogfish, frog, and rabbit should be studied from Fig. 390, p. 506.   Fig. 392, p. 509, is important.   Fig. 391, p. 508, shows the male organs in position.

H. and C.   Study pp. 254 (bottom) to 258.   Study Figs. 126 and 127.   Note that only the left testis in Fig. 126 is dissected from its scrotal sac.

Note—These references should be consulted again when the reproductive organs are being dealt with in detail.

The Excretory Organs

W. and D.   Read p. 75, section 14, for anatomy and function of the kidney.   Study carefully Figs. 26 and 27; Fig. 26 is, of course, diagrammatic.   See also p. 75, the paragraph above Fig. 26.   Study section 9, p. 68, which is important.   All organs of excretion and their work are given.

B.   Read pp. 505 (bottom) to 507, much of which is comparative with the organs in the frog and dogfish.   See Fig. 391, p. 508.

H. and C.   Read pp. 253 to 254 and study Figs. 124 and 125, p. 254.

Adrenal Bodies

A very interesting account of the functions of adrenalin (which is now synthesised in the chemist's laboratory) as a stimulant to the heart, etc., will be found in *The Science of Life* (Wells, Huxley, and Wells), p. 66 and p. 98.

W. and D.   Slight reference is made on p. 36.   Note that the right adrenal is hidden by the right kidney.

B. See p. 507 (middle).   The position is mentioned, and the left adrenal is seen in Fig. 391, p. 508; the right adrenal is hidden by the right kidney.

H. and C. See p. 251, where the alternative name, suprarenal bodies, is given. The phrase " anterior to each kidney " does not always apply, since the right adrenal is usually found to be hidden by the right kidney. Note the interesting remarks on the function.

The Liver

W. and D. Read section 13, pp. 73 to 75, where a full description of the form, structure, and functions is given. Read again section 9, p. 68, regarding the excretory function of the liver.   Read also section 13, p. 18, on the bile and its actions.

B. See p. 503 for a short description, attachment of the liver and position of the gall bladder and bile duct.   Fig. 386, p. 501, shows the general position.

H. and C. A short reference is made on p. 237 (bottom) which you have already seen when reading about digestion. Revise the functions of bile, p. 240.

The Sympathetic System

W. and D. Read again section 4, pp. 112 to 113, consulting Fig. 55, p. 111.

B. See again p. 521, l. 7. Note the sympathetic cord at the side of the dorsal aorta in Fig. 401.   It would be well to read the section on the sympathetic system in the frog, p. 86.

H. and C. Read second paragraph of the section on the spinal and sympathetic nerves, p. 264.   You are advised to read also the section on the sympathetic nervous system, p. 177, consulting Fig. 88.

The Thorax

W. and D. Read section 7, p. 5, consulting Fig. 2 B, p. 4. Decide which part of the thorax is indicated in the section,

in view of the position of the heart and aorta. Read also section 9, p. 6.

Study Chap. IV., pp. 37 to 40 on respiration. Study sections 10, 11, 12, and 13, pp. 30 to 33 (top), and section 8, pp. 27 and 28, for the heart and blood vessels of the thorax. The thymus gland is referred to at the top of p. 36.

B. Read p. 481, l. 6 to top of p. 482, consulting Fig. 371 for the general disposition of the organs of the thorax. Read p. 505 for mention of the thymus gland and a description of the respiratory organs.

For the heart and blood vessels read pp. 510 (bottom) to 515. See also footnote, p. 522 for remarks on nerves to the heart.

H. and C. The diaphragm and cavities of the thorax are described on p. 232 under "Coelom." Read the section on the respiratory system, pp. 241 to 242 with special reference to the anterior system.

Note the reference to the thoracic duct under "Lymphatic System," p. 249. The thymus gland is referred to on p. 251.

Reproductive Organs

See references under Gonads (p. 17), which revise.

The Neck

In preparation for the dissection of the neck, make sure of your knowledge of the blood vessels—external and internal jugular veins, facial veins, and the carotid arteries. You are acquainted in a general way with the larynx, trachea, and oesophagus.

W. and D. Study sections 15 to 18, pp. 122 to 124, on the cranial nerves which you will meet with in the dissection of the neck. It would be well to read also section 8, p. 118. Consult Fig. 61, p. 123, noting the course of the recurrent laryngeal nerve on each side.

The larynx and trachea are described in section 3, p. 38. The thyroid gland is referred to at the top of p. 36.

B. An excellent figure of a dissection of the neck of the rabbit is given on p. 504. Many structures are, of course, omitted, since the figure would be overcrowded if all were included, but most of the principal structures are shown. The muscles covering the trachea are removed.

Read p. 505 for the thyroid gland, larynx, and trachea. The cranial nerves of the neck are described on pp. 521 (bottom) and 522.

H. and C. A useful diagram of the dissection of the neck is given on p. 263. See pp. 241 and 242 for a description of the larynx and trachea.

For the nerves of the neck see pp. 248 (" The Glosso-pharyngeal ") to 250 (to line 11 from the bottom). The thyroid and its importance are well described on p. 236.

The Salivary Glands

W. and D. Though no reference, beyond their names, is made regarding the salivary glands, read " Saliva," section 7, p. 15.

B. See p. 500 (bottom) for a short description of the glands. See Fig. 385 for the positions of the sublingual and submaxillary glands.

H. and C. See p. 236 (bottom) and also p. 239, second paragraph under "Digestion of Food." See Fig. 114, p. 133, for the positions of the sublingual and submaxillary glands.

Buccal Cavity and Pharynx

W. and D. Study sections 8 and 9, p. 16; section 17, p. 94 (on the palate); and section 3, p. 126 (taste organs) with figure of the tongue. A reference to the Eustachian tube connection with the narial passage is given on p. 129, end of top paragraph. Mention of the tonsils is made on p. 36 (top).

B. See pp. 498 (middle) to 499 and Fig. 385.

H. and C. Read p. 232 (bottom) to p. 233 (top) and p. 236 (middle) to 237 (middle).

Dissection of the Heart

W. and D.   Read section 12, pp. 31 and 32, where the valves of the heart and their action are described.

B. See p. 510 (bottom) and Fig. 393, p. 511, which shows the internal structures of the heart.

H. and C.   See pp. 243 (bottom) to 244 for internal structures of the heart.

The Larynx and Trachea

W. and D.   Nothing beyond a general description is given in section 3, p. 38.

B.   Nothing is given beyond a general description of the respiratory organs, p. 505.

H. and C.   See p. 241-2 for details of the larynx and trachea.

The Brain.

W. and D.   Study pp. 114 to 118, paras. 6 and 7, and Figs. 56 to 59.

B.   Study pp. 516 to 522, and Figs. 398 to 400.

H. and C.   Study pp. 258 to 261 and Fig. 128.

SECTION II

LABORATORY WORK

THE SKELETON

As in all vertebrates, the skeleton consists of two chief parts; the **axial skeleton,** comprising the skull and vertebral column, and the **appendicular skeleton,** including the limbs and their supports, the limb girdles.

A—THE AXIAL SKELETON

Although the rabbit is generally used, chiefly because of the ease with which it can be obtained and its familiarity, as a representative of the Class Mammalia, the **skull** of this animal, in many of its features, is not as suitable a subject for the presentation of the characteristics of the mammalian skull as could be desired. It is therefore usual to utilise that of the dog, which for one thing is larger, and is, in some respects, more representative. A description of the skull of the dog will be given first, followed by a brief account of the particular features of that of the rabbit for purposes of comparison.

The Skull of the Dog

In the examination of the skull, it is best to commence with the longitudinal vertical section, because it is in this view that a clearer conception of the arrangement of the bones of the cranium can be obtained.

[In cutting through the skull it is usual for the saw-cut to pass just to one side of the median line. As a result of this, the medianly placed bones, such as the vomer and mesethmoid, are retained in one half and are absent from the other.]
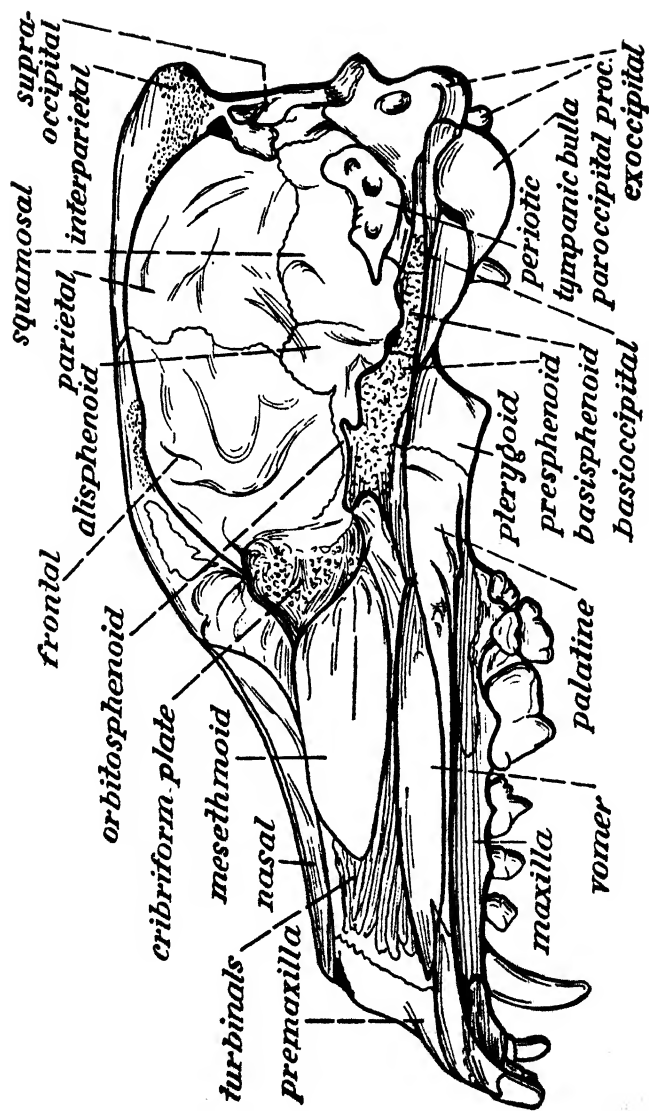
Fig. 1.—Longitudinal section of the skull of the dog.

supra-occipital

squamosal

parietal

interpretal

frontal

alisphenoid

orbitosphenoid

cribriform plate

mesethmoid

nasal

turbinals

premaxilla

periotic

tympanic bulla

paroccipital proc.

exoccipital

pterygoid

presphenoid

basisphenoid

basioccipital

palatine

maxilla

vomer

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The skull can be most conveniently considered under: (1) the **cranium** proper or brain box immediately enclosing the brain, (2) the **sense capsules,** (3) the **jaws,** (4) the **hyoid.** As is the case with all bony skulls, some of the bones, termed cartilage bones, are derived from the ossification of a cartilaginous chondrocranium, and others, termed membrane bones, from the ossification of membranes. These processes, however, occur during the development of the embryo, and in the adult skull the distinctions between the two types of bone are not self-evident. Moreover, the ensheathing character of the membrane bones is not obvious; in fact, they have in most cases come to lie edge to edge with the cartilage bones, and the line of separation between them is shown by the sinuous " sutures " outlining the individual bones. The cartilage bones will be indicated by (c) after the name.

(1) THE CRANIUM. Theoretically the cranium is made up of three rings of bone usually termed the **occipital, parietal,** and **frontal** segments. These are, however, not completely continuous with one another, for inserted between the occipital segment and the parietal segment are intrusions from the auditory capsule and the upper jaw, but it is best to consider the bones forming the cranium proper first.

Examining the section, and commencing with the cranium, it will be seen at once that the floor of the cranial cavity is composed of three bones, each seen in section. These are, passing from the hinder end of the cranium forwards, the **basi-occipital** (c), the **basi-sphenoid** (c), and the **pre-sphenoid** (c) respectively. These are called the three **bases cranii,** and form the bases of the occipital, parietal, and frontal segments of the cranium. Take the occipital segment first. Arising from the side of the basioccipital is the **exoccipital** (c), and, in the complete skull, forming a bridge between the two exoccipitals is the median **supra-occipital** (c)—seen cut through the middle in the section. These four bones form a bony ring surrounding the foramen magnum and extending almost to the

crest of the cranium. The outlines of these bones are not very distinct as there has been considerable fusion between them.

The bones of the parietal segment are not much more clearly defined, but in most cases they can be seen more clearly if the cranium is held against a bright light, when their outlines can be detected. Beginning with the basi-sphenoid, the rather small elliptical **alisphenoid** (c) will be seen inclined at an angle to it and lying at some distance from the exoccipital, for it is here that the **periotic bone** (c)—readily distinguished by the numerous apertures or
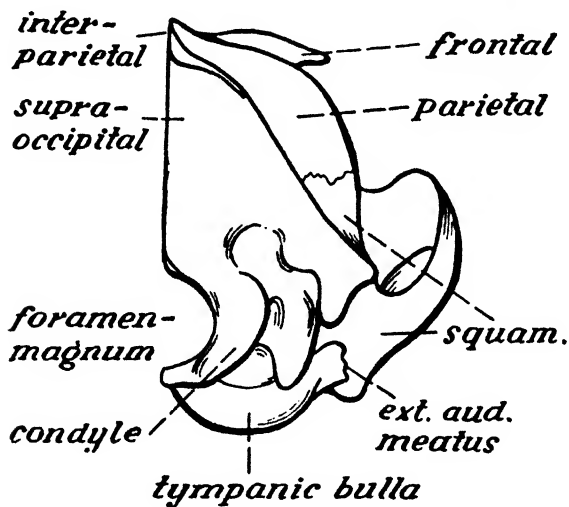
Fig. 2.—Posterior view (right half) of the skull of the dog.

foramina in it—which encloses the inner ear, and the **squamosal bone** from the upper jaw intrude between the occipital and parietal segments. With its antero-ventral edge resting on the alisphenoid and extending backwards across the top of the squamosal to the exoccipital is the **parietal bone.** This is a large bone which extends upwards

and joins its fellow of the opposite side in the middle line of the roof of the cranium, except posteriorly. Here, the two bones are separated by the slender **interparietal,** which lies in front of and above the supra-occipital, forming the well-defined crest at the hinder border of the cranium.

In the frontal segment, the **orbitosphenoid** (c), also somewhat elliptical in shape and perforated by a large foramen (the optic foramen), arises from the side of the presphenoid (c) and extends forwards to the front of the cranium. Resting on it and completing the anterior half of the cranium is the **frontal** bone. This is very thick in front but thins out where it joins the parietal and the alisphenoid. The two frontal bones meet in the middle line of the roof of the cranium. The cranial cavity is closed anteriorly by a bone which can be easily recognised by the numerous perforations in it. This is the **cribriform plate** of the **mesethmoid** (c), and through the perforations pass the fibres of the olfactory nerves.

Having now worked through the bones forming the cranium from the inside, you should proceed to identify their positions on the external surface. In the first place, the three *bases cranii* will not be so easily identified because in the adult skull they are closely fused together and the sutures between them are not clearly defined externally. But, by comparing the section with the complete skull, their positions can be established. The **basioccipital** (c) can be readily identified lying anterior to the large bony facets (the **occipital condyles**) which occupy the lower border of the foramen magnum, its posterior margin being part-overlapped by them. The position of the **basisphenoid** can also be determined—though the suture between it and the basioccipital may not be seen—by the fact that it tapers anteriorly so that it is roughly triangular in shape and the suture between it and the presphenoid is usually distinct. In this view, what is visible of the **presphenoid** is an insignificant triangular-shaped bone lying immediately in front of the basisphenoid, but its true size and thickness you will have gathered from the examination of the section.
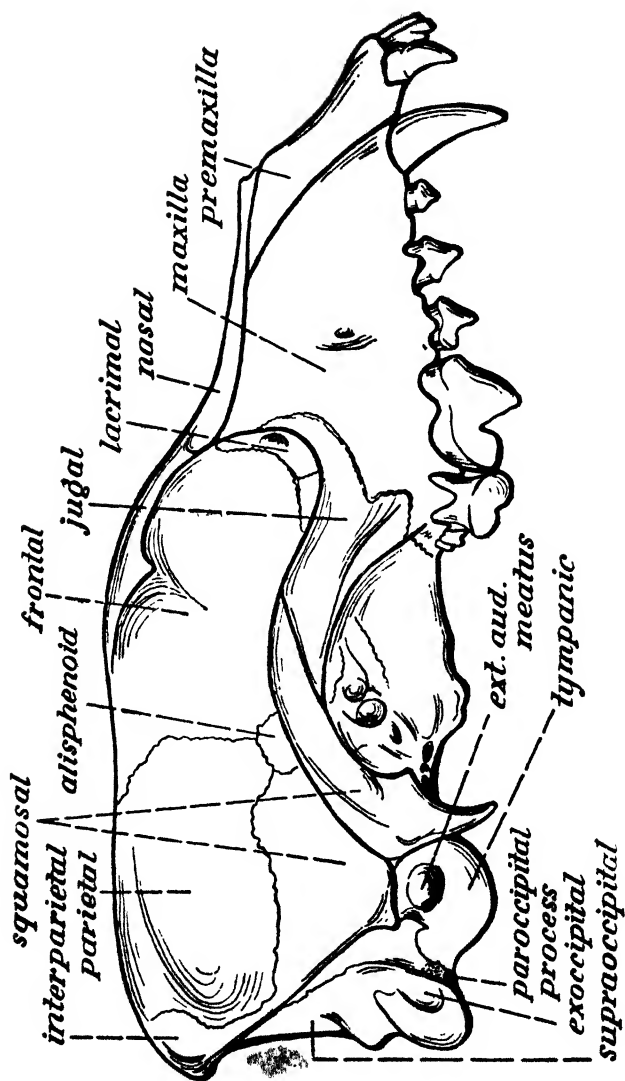
Fig. 3.—Side view of the skull of the dog.

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[If it is possible it is instructive to examine a young puppy's skull for these bones, for here their limits are clearly defined.]

Having now established the positions of the three *bases cranii*, the positions of the other bones forming the cranium can be made out. Take the occipital segment first. The position of the **exoccipitals** can be determined by the occipital condyles. Note the way in which these overlap the basioccipital, almost meeting ventrally. Also at the sides of the occipital condyles a downwardly projecting process—the **paroccipital process** of the exoccipital—will be seen on each side. To these processes are attached muscles (the digastric, etc.), in connection with the lower jaw. The sutures between the exoccipitals and the supraoccipital are not distinct, the occipital segment showing considerable fusion between its constituent bones. The position of the **supraoccipital** can be determined, however, as a somewhat convex prominence above the exoccipitals and reaching almost to the crest of the cranium.

Now take the parietal segment. The position of the basisphenoid has already been determined. On each side of the basisphenoid is a markedly convex bone—the bulla of the **tympanic bone**, part of the auditory apparatus—and immediately above this a large bone which consists of an outwardly projecting piece forming part of the strong bony arch which extends to the front of the skull; its expanded base is incorporated into the side of the cranium ; this is the **squamosal bone** which really belongs to the upper jaw. Inclined at an angle in front of the squamosal will be found the **alisphenoid** (c), and above, the **parietal,** the major part of the ventral edge joining the squamosal and the remaining part resting on the alisphenoid. The two parietals meet in the middle line on the roof of the cranium, the suture between them being usually distinct. Posteriorly, they are separated by the slender **interparietal bone.**

Next consider the frontal segment. As you have already seen, the presphenoid is largely hidden by the surrounding bones, but you have established its position. Ignoring for the present the two downwardly projecting sheets of bone at the sides of the presphenoid, the **orbito-**

sphenoid (c) will be seen as an elliptically shaped bone inclined forwards at an angle and lying in the lower part of the orbit in front of the large foramina found at the back of the orbit. Resting on the orbitosphenoid, but projecting in front of it, is the **frontal bone** which extends upwards meeting its fellow of the opposite side in the middle line.

This completes the examination of the cranium proper.

(2) THE SENSE CAPSULES. In relation with the cranium are to be found the sense capsules enclosing the organs of special sense. Of these, the auditory capsule, enclosing the auditory organ or ear, and the olfactory capsule enclosing the olfactory organ, are closely fused on to the cranium. The optic capsule, however, which is represented by the sclerotic coat of the eyeball, is not so fused, but is accommodated in the bony depression—the orbit—at the side of the cranium, and, of course, was removed in the preparation of the skull.

In dealing with the auditory and olfactory capsules it is well to consider them in both the entire skull and the section together.

The **auditory capsule,** as you have seen in the examination of the cranium, has intruded between the occipital and parietal segments so that it has come to lie partly within the cranial cavity itself. This portion is represented by the **periotic bone** (c) which you have already seen within the cranium, and which encloses within itself the membranous labyrinth of the inner ear. Examining the section, you can quite readily see that the periotic bone is in close relationship with the **tympanic bone,** which, as you have seen before, lies between the basisphenoid and squamosal bones. Closer examination of the tympanic bone will reveal that it encloses within its convexity a cavity—the tympanic chamber. This chamber communicates with the exterior by a large passage, the **external auditory meatus,** which lies at the base of the outwardly projecting portion of the squamosal. The cavity within the bone has still another aperture leading into it. Examining the under

surface of the cranium it will be seen that at the anterior border of the tympanic bone there is an aperture, shallowly crescentic in shape and partly overhung by a lip of the bone itself. Take a seeker or needle and insert it into the aperture, when it will be found to enter the tympanic chamber, whereas neighbouring apertures lead to the cranium. This aperture is that of the **Eustachian tube or Eustachian canal**, which in the living animal serves as a channel or communication between the tympanic chamber and the pharynx (see page 156). In life the external auditory meatus is closed by the ear drum or **tympanic membrane,** which is connected to an aperture, the fenestra ovalis, in the periotic bone by the chain of three auditory ossicles, the malleus, incus, and stapes, by which the vibrations set up in the tympanic membrane are transmitted to the membranous labyrinth of the inner ear enclosed within the periotic bone. The function of the Eustachian canal is to maintain an equality of atmospheric pressure on both sides of the tympanic membrane. The auditory capsule is thus represented by the periotic and tympanic bones.

As was mentioned above, the **optic capsule** is represented by the sclerotic coat of the eye-ball, which is lodged in the bony orbit. In the dog, the orbit is the depression at the side of the cranium which is bounded above by the frontal bone and below by the anterior part (**jugal**) of the bony arch (**zygomatic arch**), which has been noticed before, stretching from the front of the cranium to the occipital region. The anterior border of the orbit is limited by the **maxilla,** but posteriorly the margin is incomplete, being indicated by a downwardly directed process from the frontal and an upwardly directed process from the jugal, so that the orbit is not completely separated from another depression (the **temporal fossa**) lying behind it at the side of the cranium. Within the anterior border of the orbit is a small bone, the **lacrimal,** perforated by a small canal —the lacrimal canal. The remainder of the bony socket is bounded by the frontal and orbitosphenoid bones.

The **nasal capsules** lie in front of the cranium and form

the snout. To get a correct impression of these capsules it is advisable to examine the section of the skull. In mammals, the olfactory capsules have associated with them a modification of the bones of the roof of the mouth cavity, due to the formation of a hard, bony palate, by which the respiratory channel is separated from the food channel. You will find, therefore, that in addition to the bones which enclose the olfactory capsule itself, you will have to consider bones which also originally formed part of the upper jaw. Each olfactory organ is lodged in a bony chamber, the position of which is marked on the outer surface by the **nasal bones.** Identify the positions of these bones first in the entire skull and then in the section. Each will be found to consist of an elongated bone extending from the large aperture at the front of the snout to the anterior margin of the frontal bone of its side. It is separated by sutures from its neighbour and from the bones lying on the outer margin. Now look at the half-section of the skull from which the median bones, as mentioned before, are absent. From this it will be seen that the aperture at the front of the snout, where in life the **external nares** or nostrils are situated, leads really into two chambers. The upper one, which is the olfactory capsule proper, is closed posteriorly by the previously noticed cribriform plate and is itself almost filled with the friable scroll bones or **turbinal bones,** but below them is a channel with a thin bony floor which passes backwards to the region of the presphenoid. This is the respiratory channel whereby the air taken in at the external nares is conducted, after first passing over the folds of the maxillo-turbinal bones by which its temperature is raised, to the back of the throat for entry into the lungs through the glottis.

In this same half-section it can be seen that whereas the capsule is bounded above by the nasal bones, the sides are formed by upwardly directed extensions of the **premaxilla** and the **maxilla.** The positions of these bones are perfectly obvious because both carry teeth. Determine their positions in the entire skull (or section) and trace their

outlines. The premaxilla forms the lower margin of the large aperture at the front of the snout and sends an upward extension between the nasal bone and the succeeding bone, the maxilla. An upward extension of the maxilla reaches the upper part of the nasal and joins the frontal above, and laterally, the jugal.

Now turn to the half-section which contains the median bones. Here you will see that the olfactory capsule is bounded on its inner side, and incidentally is separated from its neighbour, by a vertically situated sheet of thin bone, the **mesethmoid** (c), which extends from the cribriform plate nearly to the front of the snout. In life, this bone is continued forwards to the external nares as a thin sheet of cartilage, the **internasal septum**. The upper border of the mesethmoid is fused to the under side of the nasal bones where they join in the middle line, but its ventral margin is free. Actually, this ventral margin is in close relation with another structure which is fused in the middle line with the thin bony floor of the respiratory channel, an inward extension of the maxilla. This structure is the **vomer**. In cross section it forms a Y-shaped pillar arising from the bony palate, and the mesethmoid lies on end in the fork of the Y, thus: ⵖ. Posteriorly the vomer becomes free from the bony floor of the respiratory chamber and is fused to the anterior end of the presphenoid.

The scroll bones, or turbinals, are really inward growths from the sides of the capsule. They are very friable and are often broken away from the skull with handling, but if they are complete, it will be found that they consist of three series in each capsule; the **maxillo-turbinals**, lying nearest to the external nares and almost filling the whole respiratory channel, the **ethmo-turbinals**, lying more posteriorly and fused to the cribriform plate, and the **naso-turbinals**, attached to the under side of the nasal bones.

(3) THE JAWS. (*a*) *The Upper Jaw*. A number of points in connection with the upper jaw have already been mentioned when considering other parts of the skull, but now it may be examined as a whole. The upper jaw has

not only become fused to the cranium and capsules, but also participates in the formation of the palate and serves for the articulation of the lower jaw. Consider it first in the entire skull. The anterior portion is formed by the **premaxilla,** which, as has already been noticed, forms the lower border and lateral margins of the large aperture at the front of the snout. Notice that the premaxilla is also continued inwards into the roof of the mouth, and that there is a large foramen in this inwardly directed portion. Behind the premaxilla lies the **maxilla,** which extends backwards along the outer margin of the snout to the anterior border of the orbit. The upward and inward extensions of this bone have already been noticed in relation to the nasal capsules. From the posterior margin of the maxilla extends the strong bony arch, the **zygomatic arch,** passing backwards to the occipital region of the cranium. This arch, as has already been stated, is made up of the **jugal** and the **squamosal** bones. The former is ankylosed to a backwardly directed spur of the maxilla, but the suture between them can usually be seen; the latter consists of an expanded part which has intruded between the tympanic and the parietal bones, as was seen in the examination of the cranium, and a forwardly directed spur which joins the jugal by a diagonally directed suture which usually remains distinct. On the under side of this spur, just where it arises from the expanded portion, is a shallow depression into which the articular portion of the lower jaw fits.

As has already been pointed out, some of the bones of the upper jaw participate in the formation of the palate. Now the roof of the mouth (see page 153) is made up of the hard and soft palates. The former, as its name implies, has beneath it a foundation of hard bone, while the latter consists of soft membranous tissue and has at its posterior margin the internal aperture of the respiratory channel. The bony foundation of the hard palate is formed by the inward growths of the premaxillae and maxillae meeting in the middle line, the latter partly surrounding the **palatines** which also have met in the middle line. At the posterior margin of the hard palate, the lateral borders

of the palatines are continued backwards, where, together with the **pterygoids** they form the lateral walls of the respiratory channel, the floor of this portion of which is the soft palate. The positions of the palatine and pterygoid bones can be clearly made out as they are separated by clearly-defined sutures, the former from the maxilla and presphenoid and the latter from the sides of the presphenoid and basisphenoid.

(*b*) *The Lower Jaw*. In the dog, each half of the lower jaw or mandible consists of a single bone, the **dentary.** This is made up of the main shaft, in which lie the teeth, and at the posterior end are upwardly directed projections for the attachment of muscles and for articulation with the upper jaw. Of these projections, the uppermost is the **coronoid process** to which the temporal muscle is attached.

This process, as you will see, is made up of a thin bony projection, smooth on its inner face and with a marked depression on its outer. Below this is a strongly developed, horizontally running ridge of bone, round and smooth on its outer face. This is the **articular process,** sometimes called the condyle, but the term articular process is preferable so that you will not confuse it with the occipital condyle. At the lower margin of the mandible is a small hook-like projection, the **angular process** or **angle** of the lower jaw. The two halves of the lower jaw are joined together anteriorly at the median **symphysis.**

Now fit the lower jaw to the upper, and note how the articular process fits into the depression in the squamosal. Note also how the coronoid process projects upwards and lies in the temporal fossa.

(4) THE HYOID. The hyoid is commonly lost in the preparation of the skeleton, but you will see its position in the floor of the pharynx during the dissection of the neck (see page 142). The **hyoid bone**—the body of the hyoid—is triangular in shape, and projecting from the posterior angles are the slender **posterior cornua.** The **anterior cornua** are represented by short processes from the body of the hyoid immediately in front of the posterior cornua.

[You may note that the hyoid and the cartilages of the larynx are the remnants of embryonic visceral arches.]

(5) THE TEETH. In all mammals, the teeth, although developing independently of the bony skull, are lodged in depressions or sockets, termed alveoli, in certain of the bones of the upper and the lower jaws in the adult animal, so that they are usually considered in relation with the skull.

In most mammals the teeth have been differentiated to subserve different functions, and they may be divided into four kinds; (1) the incisors with their chisel-shaped edges, are placed at the front of the jaws; (2) the canines, sharply pointed and lying next to the incisors; (3) the pre-molars; and (4) the molars. This type of dentition is termed heterodont, the teeth being of varied forms. Considering the heterodont mammals as a whole, what is regarded as the typical number of each kind of tooth in the upper and lower jaws, has been represented by the typical dental formula, in which the sequence and number of teeth on each side is written thus: i $\frac{3}{3}$, c $\frac{1}{1}$, pm $\frac{4}{4}$, m $\frac{3}{3}$ = $\frac{11}{11}$ × $\frac{2}{2}$ = 44, the figures in the top row representing the numbers in the upper jaw and those in the lower, the lower jaw, the total being that in both upper and lower jaws. Only a few mammals (*e.g.* the pig) have this full complement of teeth, and in the dog the dental formula is i $\frac{3}{3}$, c $\frac{1}{1}$, pm $\frac{4}{4}$, m $\frac{2}{3}$ = 42, the last molar on each side in the upper jaw being absent.

[In many mammals the adult dentition, usually termed the permanent dentition, is preceded by a so-called milk dentition in which only certain of the permanent teeth are represented. The incisors and the canines are usually represented but of the remainder, only the premolars— hence the name—and in a young skull it sometimes happens that certain of the deciduous milk teeth may be present together with the permanent teeth.]

Now examine the teeth in the jaws, taking the upper jaw first. The three incisors will be found in the premaxilla; note their chisel-shaped edges. The canines,

premolars, and **molars** are lodged in the maxilla. Note there is a small space between the incisors and the canines, In some mammals, *e.g.* rabbit—see later—where the canines are absent, there is a large space between the incisors and the premolars, which is called a **diastema.** The canines are strongly developed and sharply pointed. Then follow the premolars. Notice the great difference in size among them. The first, very small, the second and third roughly the same size, and the fourth very large. Each has two small and one strongly developed pointed projection or cusp which is very large in the fourth. Examine this tooth carefully. It will be found that the outer surface is markedly convex whilst the inner surface is flatter. The reason for this will be evident after the teeth of the lower jaw have been considered. The molars differ markedly from one another. The first is much the larger and is produced inwards to form a large " crown." The second is similar in form but much smaller.

In the lower jaw the incisors occupy the extreme anterior margin, while the canines are more laterally placed. Of the premolars the first is the smallest, the second and third much about the same size, and the fourth the largest, but not so strongly developed as in the upper jaw. The first molar, however, is very strongly developed, in fact is the largest tooth in the lower jaw. Notice that in this case it is flattened on the outside and convex on its inner. The second and third molars are quite small, the third being the smallest.

In connection with the form of the teeth, it is interesting to consider this in relation with their functions. The incisors, with their chisel-shaped edges, are primarily cutting teeth, but this function is not so pronounced in the dog as in other mammals such as the rabbit, the dog using them more for seizing or prehension. The strongly developed canines are used in the dog and its near relatives more for attack on enemies and prey, their sharp points being pre-eminently adapted for tearing and gashing. In many mammals, the function of the premolars and molars is for grinding the pieces of food which have been divided

by the incisors. In the dog and most Carnivora, the last premolar in the upper jaw and the first molar in the lower are modified as shearing teeth; they are sometimes called the **sectorial** or **carnassial** teeth. Put the lower jaw into position and note that the last premolar of the upper jaw slides over the first molar of the lower comparable to the blades of a pair of shears. Also that the pointed projections on the premolars in both jaws form a serrated edge for cutting purposes. It is with these teeth that the dog effects the division of large pieces of flesh and even bones. The flattened " crowns " of the molars in the upper jaw and the last two in the lower, are for crushing hard portions of food rather than grinding them up. [Compare the functions of the teeth in the rabbit.]

Drawings.—Make drawings of the dog's skull from the dorsal and ventral aspects. Also make a drawing of the sectional view of the half skull containing the median bones.

Laboratory Notes.—Make notes on the forms and functions of the teeth.

(6) THE APERTURES OF THE SKULL. In the account of the skull which has so far been given, little reference has been made to the numerous apertures which are to be found in various parts of the skull, for it has been thought advisable for you to obtain first an idea of the positions of the bones and their relations to one another. Now, however, you should be able to identify the bones, and are in a position to examine the apertures and to consider their purpose. For convenience, begin with the hinder end of the cranium. The occipital segment forms a bony ring which surrounds the **foramen magnum** through which the hinder part of the brain issues from the cranial cavity to pass into the spinal cord. On the under side of each exoccipital bone, lying anterior to the condyle, is a small aperture. Pass a bristle or seeker into it, when it will be found to protrude into the cranial cavity. This aperture is the **condylar foramen** through which the XIIth (hypoglossal) nerve issues. Anterior to this, and lying under the inner posterior margin of the tympanic bulla, between it and

the exoccipital, is a large elongated aperture inclined at an angle to the long axis of the skull. This is the **foramen lacerum posterius**; through it issue the IXth (glossopharyngeal), Xth (vagus), and XIth (spinal accessory) cranial nerves and the internal jugular vein.

Take a bristle and pass it into the aperture in one of the half-sections of the skull. Usually the bristle will project into the cranial cavity through one of two apertures between the periotic and exoccipital bones, but it can also be made to pass through an aperture underneath the edge of the periotic and enter the cranial cavity in the region of the basisphenoid. It is through this latter aperture that the internal jugular vein leaves the cranium. On the outside of the tympanic bone posterior to the external auditory meatus and lying at the side of the paroccipital process, is another elongated aperture, the **stylomastoid foramen**, through which the VIIth (facial) cranial nerve issues. This nerve, together with the VIIIth (auditory) on leaving the brain, enters the periotic bone by the passage, the **internal auditory meatus**, seen (in the half-section) occupying the centre of this bone. The VIIIth nerve then passes to the inner ear within the periotic, whilst the VIIth issues through the stylomastoid foramen; the path which it traces is not a straight one, however, so that it is with some difficulty that a bristle can be made to pass along it. The **external auditory meatus** has already been noticed. Still in the region of the tympanic bulla, and lying in front of the external auditory meatus between it and the squamosal bone is a large foramen, the **postglenoid foramen**, through which a vein leaves the cranial cavity. Pass a bristle into it and within the cranium the bristle will be seen lying between the outer side of the periotic bone and the cranial wall.

In front of the tympanic bone, between it and the basisphenoid and alisphenoid, are three apertures. The middle one, distinguished by the projecting lip of the border of the tympanic, has already been identified as the aperture of the **Eustachian canal**. On the basisphenoidal side of the Eustachian aperture is the **foramen lacerum medium,**

through which the internal carotid artery enters the cranial cavity. Pass a bristle or seeker into it and note the position of its opening within the cranium. The remaining aperture of this group, which lies in the hinder part of the alisphenoid, is the **foramen ovale** through which the mandibular branch of the Vth (trigeminal) cranial nerve issues from the skull.

Passing now to the hinder part of the orbit, another group of three apertures, close together, will be seen, lying in the posterior part of the alisphenoid and between it and the orbitosphenoid. Of these three apertures, the middle one, the **foramen lacerum anterius,** situated between the orbito- and ali-sphenoids is the largest. Through this aperture the IIIrd (oculo-motor), IVth (patheticus), and VIth (abducens) cranial nerves (those supplying the eye muscles) leave the cranium, and also the ophthalmic branch of the Vth. This aperture is so large that the position of its internal opening within the cranial cavity can be readily seen. Immediately in front of the foramen lacerum anterius is a slightly smaller aperture lying in the orbitosphenoid; this is the **optic foramen** through which the IInd (optic) cranial nerve issues on its way to the eyeball. Its opening within the cranium is also obvious. Posterior to the foramen lacerum anterius is the smallest aperture of the three, the **foramen rotundum,** through which passes the maxillary branch of the Vth cranial nerve. This aperture opens into the **alisphenoid canal.** Take a bristle and insert it into the foramen rotundum. If the bristle is held at an obtuse angle to the alisphenoid, it enters the cranial cavity, but if held parallel to the bone it passes along a canal in the alisphenoid and issues at an aperture on the inner face of the foramen ovale. Through this canal passes the external carotid artery.

At the front of the orbit are four apertures. Of these, the largest lies between the jugal and the maxilla and issues on the outer face of the maxilla above, and in line with the third premolar tooth; this is the **infraorbital foramen.** Through this canal passes the maxillary branch

of the Vth cranial nerve, which, after issuing from the cranium by the foramen rotundum, traverses the orbit and reaches the snout by the infraorbital foramen. Pass a bristle through the canal from its orbital end and note where it emerges on the maxilla. Within the orbit, at some short distance behind the aperture leading to the infraorbital foramen are two apertures, the **internal orbital foramina**, situated close together. The lower of these has two channels leading from it. If a bristle is pushed into the more anterior of these, it will protrude from the more anterior of the two **posterior palatine foramina** in the hard palate between the palatine and maxilla. If, however, it enters the more posterior one, it emerges from the more posterior of the posterior palatine foramina. A bristle placed in the upper internal orbital foramen enters (as you can see in the half-section from which the median bones are missing) the respiratory channel of the olfactory capsule. At the anterior edge of the orbit, perforating the lacrimal bone, is the **lacrimal foramen** which leads into the **lacrimal canal**. Using the half-section which lacks the mesethmoid, push a long bristle into the lacrimal foramen and note that it emerges through a small aperture in the inner side of the maxilla within the nasal chamber and below the attachment of the maxilloturbinals. The lacrimal canal conveys the secretion of the lacrimal glands in the orbit (for the lubrication of the eyeball) to the nasal chamber.

Turning once more to the palate, in the premaxillar portion are two large apertures, the **anterior palatine foramina**, which communicate with the nasal chamber. Through them pass part of the Vth cranial nerve and also a canal which leads into the Organ of Jacobson. The large **narial aperture** has already been noticed. In life, this is divided by a cartilaginous nasal septum, and the **external nares** or **nostrils** are situated at the upper part.

Limiting the nasal capsule posteriorly is the cribriform plate of the mesethmoid. The numerous apertures in this plate afford passage for the branches of the Ist (olfactory) cranial nerve.

In each half of the lower jaw there are two foramina, one on the inner and the other on the outer face. The one on the inner face is situated at the posterior end of the jaw above the angular process and almost in line with the articular process. This is the **inferior dental foramen** and leads into the dental canal along which pass a branch of the Vth cranial nerve (the dental nerve) and an artery. On the outer surface, almost in line with the first premolar is another aperture, the **mental foramen,** through which the dental nerve emerges.

Drawing.—In the diagrams you have already made, insert the positions of as many of the apertures as are visible in those views.

Laboratory Note.—Make a list of the apertures in the skull and note what passes through each.

The Skull of the Rabbit (Comparative Points)

The first and most obvious difference between the skull of the rabbit and the dog is the character of many of the bones in the former. Instead of the smooth, hard, uniform surface found in the dog's skull, many of the bones are spongy in texture with large spaces in them. This is particularly so in the bones in the occipital region and in the maxillae.

The constitution of the cranium proper offers few points of difference, for, apart from differences in shape, the arrangement of the bones is the same as in the dog.

In the sense capsules notice that although the auditory capsule is made up of the same bones, the **mastoid** portion of the **periotic bone** (c) is more clearly visible on the surface, bordered by the supraoccipital above, the exoccipital behind, the squamosal in front, and the tympanic below. Note that the periotic also sends down a **mastoid process** closely applied to the bulla of the tympanic. The **paroccipital process** of the exoccipital is also closely applied to the bulla. The tympanic bone in addition to being inflated into a prominent bulla has a much longer tubular, bony, external auditory meatus. In the olfactory capsule the backwardly directed **spur** of the **premaxilla** reaches the frontal, completely separating the nasal from the **maxilla.**

In the orbit, the frontals are produced laterally into prominent **supraorbital ridges** and the maxilla protrudes into the orbit to form a prominent bulge of bone. The **lacrimals**—which often become detached in the dried skull —are thin plates of bone, with a notch on the outer side leading into the **lacrimal canal**.

The form of the **zygomatic arch** differs from that of the dog. It is much flatter, reducing the relative apparent width of the skull and giving to the rabbit the narrow appearance of the head. The jugal is fused to the maxilla, but extends much further back than in the dog, and forms the greater part of the lower part of the arch. The **zygomatic process** of the squamosal is relatively small and the suture between it and the jugal is horizontal and not oblique. The **articular depression** on the underside of the spur of the squamosal is much deeper and narrower than in the dog, the significance of which will become obvious when the articulation of the lower jaw is considered. Note also that the **temporal fossa** behind the orbit is practically non-existent and the absence of the upwardly directed process on the upper margin of the arch to mark the posterior limit of the orbit.

The upper jaw presents some of the most noticeable differences which lie chiefly in the condition of the **palate**. Both **premaxillae** and **maxillae** contribute to the formation of the hard palate, but the inward projection of the maxillae is confined to the posterior portion, where together with the palatines they form a bridge of bone stretching between the two jaws. In front of the bridge are two narrow elongated apertures, the **anterior palatine foramina,** extending forward to the symphysis of the premaxillae, but separated by two closely applied backwardly directed prolongations (the **palatine processes**) of these bones. These palatine processes practically meet a forwardly directed spur of the maxillae and enclose within their folded edges the Organ of Jacobson.

The **palatines** and **pterygoids** form much deeper lateral walls to the hinder part of the respiratory channel with the result that the presphenoid can scarcely be seen in

the roof of the channel, the floor of which will be formed by the soft palate. On the outer side each pterygoid meets a forwardly directed process (the **pterygoid process**) of the **alisphenoid** (c).

The lower jaws are somewhat different in shape and their articulation is unlike that of the dog. Each half consists of a stout anterior portion, which joins its fellow of the opposite side in a rather long symphysis, and a thin posterior portion which projects upwards. The **articular surface** is situated at the apex of this ascending ramus and is narrow from side to side to fit into the deep depression on the under side of the spur of the squamosal. The **coronoid process,** so strongly developed in the dog, is merely represented by an inflected spur on the grooved anterior face of the ascending portion. The **angle** is rounded with a backwardly directed projection, the angular process.

One of the most fundamental differences between the two skulls lies in the condition of the teeth. The dental formula of the rabbit is i $\frac{2}{1}$, c $\frac{0}{0}$, pm $\frac{3}{2}$, m $\frac{3}{3} = \frac{8}{6} \times \frac{2}{2} = 28$, but the teeth have been specially modified in accordance with the feeding habits of the animal. The essential feeding processes of the rabbit consist of gnawing and grinding the food, and to this end the **incisors** have been specially developed for the former purpose and the **premolars** and **molars** for the latter. If you will fit the lower jaws into position in the skull you will see that when the jaws are closed the lower incisors fall into a position just behind the anterior upper pair. The edges of these teeth are sharply chisel-shaped, due to the fact that the enamel on the front of the teeth is thicker and harder than at the back, so that the hinder portion wears away faster than the front. From their shape and position it is evident that they are pre-eminently suited for cutting through tough material, and with them the rabbit effects its often extensive gnawing operations. This entails a good deal of wear and tear on these teeth and to compensate for this, these teeth are provided with open persistent pulps so that they continue to grow throughout life. In this respect the teeth of the rabbit differ from those of most mammals.

[Sometimes the incisor teeth become loose in their sockets in the drying process in the preparation of the skull, and if a tooth is withdrawn, a considerable length of tooth will be found to have been lodged in the jaw. Also you can see that the inner end is open.] In the upper jaw the second pair of incisors are small and situated directly behind the first.

As you have seen from the dental formula, **canines** are absent in both upper and lower jaws, and between the incisors and the premolars is a large space or **diastema.**

The **premolars** and **molars** are not easily distinguished from one another, for both have become modified for grinding purposes, the " crown " of each tooth being traversed by ridges of harder material.

The apertures of the skull are not so easy to distinguish as in the case of the dog, largely due to the nature of the bones. There are also a few individual differences, though the distribution of the apertures is, in the main, the same.

The **post-glenoid foramen** is not present. On the inner side of each bulla is an aperture, the **carotid foramen,** through which the internal carotid artery enters the cranium. In the dog this artery enters through the foramen lacerum medium. The **foramen ovale** has become confluent with the **foramen lacerum medium,** being represented merely by a notch in the alisphenoid at the anterior part of the foramen. Consequently, in front of the bulla, between it and the alisphenoid, there are only two apertures instead of three as in the dog.

In the hinder part of the orbit is a vertical slit-like aperture which in the rabbit is called the **sphenoidal fissure.** This takes the place of the **foramen lacerum anterius** and the **foramen rotundum** in other mammals. The **optic foramen** is large and lies above the sphenoidal fissure. In front of the optic foramen is a small aperture, the **internal orbital foramen,** which is continuous with a groove which curves backwards over the optic foramen to the sphenoidal fissure. In the pterygoid process of the alisphenoid are three apertures. That nearest to the sphenoidal fissure transmits the internal maxillary artery

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and vein, and the other two, branches of the ramus mandibularis of the Vth (trigeminal) nerve. Between the pterygoid process of the alisphenoid and the pterygoid is the **pterygoid fossa**. The large anterior palatine foramina have already been noticed in relation with the palate. On the underside of the basisphenoid is an aperture, the **pituitary foramen**—closed by a membrane in the living animal—which leads into the depression in the basisphenoid in which the pituitary body lies.

Laboratory Note.—Make a list of the peculiarities of the rabbit's skull as compared with that of the dog.

The Vertebral Column

The vertebral column in the rabbit is divided into the typical mammalian regions: **Cervical** (7), **Thoracic** (12), **Lumbar** (7), **Sacral** (4), and **Caudal** (15 or 16). Of these, the vertebrae in the lumbar region are, perhaps, the least specialised. Though it is advisable to have available a complete skeleton also, select a single **lumbar** vertebra to begin your examination. Any vertebra will serve, though the first and second
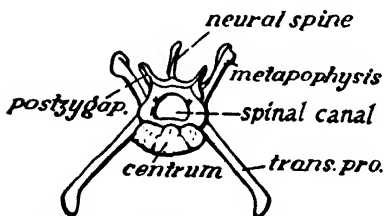
Fig. 4.—Posterior view of lumbar vertebra.

lumbar vertebrae differ slightly from the others.

Examine first one face of the vertebra. Notice that the vertebra is made up of the three typical parts. First a flattened bony cylinder, the **centrum**, which forms the central part of the vertebra and from which all the other parts arise. This is surmounted by a bony arch, the **neural arch**, which encloses the **spinal canal** (neural canal) in which lies the spinal cord. Then, projecting from each side of the centrum and arising from the dorso-lateral margin, are the **transverse processes**.

Having now familiarised yourself with the general constitution of the vertebra, examine it more in detail. In the complete skeleton notice that the centra of successive
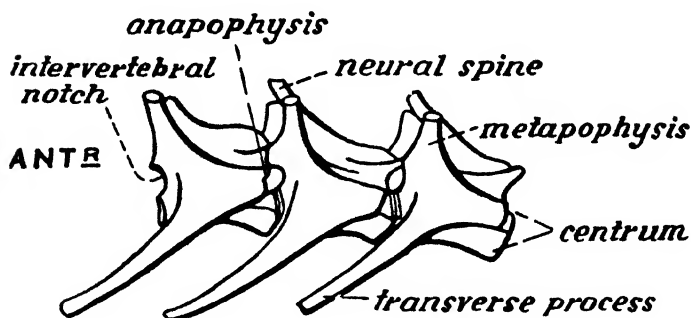
Fig. 5.—Three successive lumbar vertebrae, left side.

vertebrae do not actually touch one another, but are separated (in the dried skeleton) by a distinct brown line. This represents a circular pad of fibro-cartilage, the **intervertebral disc**, which lies between one centrum and the next and allows a certain amount of movement of one centrum on the next. Examine the centrum of the single vertebra and you will find that each end consists of a flattened, slightly convex disc which close examination will reveal is separated from the main body of the centrum

Fig. 6.—Ventral view of lumbar vertebra.

by a suture. This disc of bone is

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the **epiphysis,** which is ossified separately from the body of the centrum, but which, in the adult, has fused on to it. In addition to the attachment of one centrum to the next by the intervertebral disc, each vertebra is also articulated to that immediately in front and behind by means of articular facets arising from the neural arch, the **zygapophyses,** one pair at the front end and one pair at the hinder end. Now determine which is the anterior and which the posterior face of your specimen. In the complete skeleton you will see that the transverse processes of the lumbar vertebrae always point towards the head of the animal, so you can now orientate your specimen.
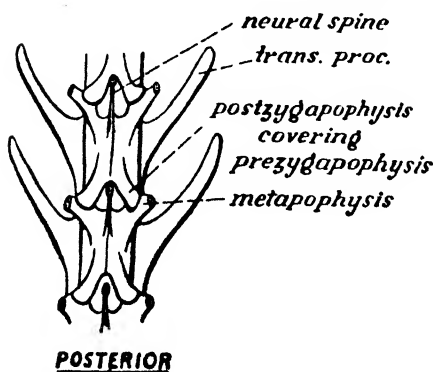
Fig. 7.—Dorsal view of two successive lumbar vertebrae.

The **pre-zygapophyses** are small projections on the inner sides of the large upstanding protuberances (the **metapophyses**) which arise from the front of the neural arch. Notice the smooth articular surface and that this surface faces upwards and inwards. The **post-zygapophyses** at the opposite end of the neural arch are quite large projections on which the articular surfaces face downwards and outwards. Examine two vertebrae fitted together and observe how the post-zygapophyses fit closely in between the metapophyses above the pre-zygapophyses, the two articular surfaces in contact. At the base of each post-zygapophysis is a small projection (the **anapophysis**) which, when the vertebrae are fitted together, lies on the outside of the base of the metapophysis. Note also in each vertebra below the

metapophysis in front and anapophysis behind is an intervertebral notch. When the vertebrae are fitted together, these notches become contiguous and form a foramen through which a spinal nerve issues.

The crest of the neural arch is prolonged upwards into a prominent **neural spine** which is more pronounced in the more posterior vertebrae of this region. From the underside of the centra of the first two lumbar vertebrae there is present a downwardly directed process, the **hypapophysis**, which is not present in the others. In the complete skeleton you will notice that the metapophyses and neural spines form a series of prominent projections on the dorsal side of the vertebral column in this region. These projections serve for the attachment of the powerful muscles of the back. Also, the transverse processes form the sides of a trough in which lie the dorsal aorta, inferior vena cava, and the sympathetic nerve chain (see pages 109, 117).

Drawings.—From a single lumbar vertebra make drawings of the anterior and lateral views, naming all the parts you have identified.

Laboratory Note.—Make a list of the characteristic features—metapophyses, anapophyses, hypapophysis, etc.—by which lumbar vertebrae are distinguished from all others.

In front of the lumbar vertebrae are found the **thoracic vertebrae,** and in the complete skeleton it will be seen that there is a gradual change in the form of the vertebrae as you pass forwards from the lumbar to the thoracic region. Examine first one of the anterior thoracic vertebrae. The parts of the vertebra, **centrum, neural arch, neural spine**—which is usually long—**transverse processes, zygapophyses,** will be evident at once. The
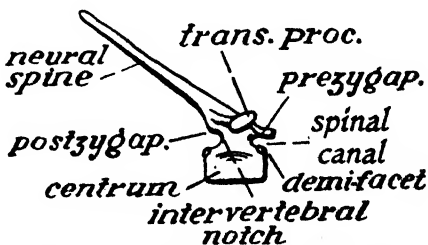
Fig. 8.—Thoracic vertebra, right side.

positions of the articular surfaces on the zygapophyses will enable you to determine which is the front and which the hinder face. The direction of the neural spine will also help. Now examine the characteristic features. The thoracic vertebrae all have in relation with them bony **ribs**, but those attached to the anterior vertebrae differ slightly from the more posterior ones. Examine a separate rib from the anterior region. It will be found to consist of a slender curved **shaft** at the upper end of which are two projections arranged so as to enclose an angle between them. That which forms a continuation of the natural curve of the shaft is rounded at the end and is termed the **capitulum**; the other, which has a flattened articular surface, the
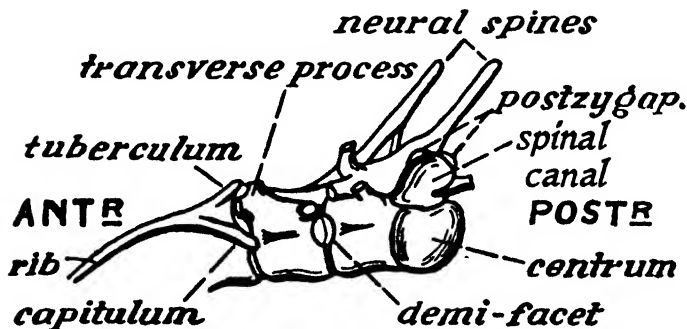
Fig. 9.—Thoracic vertebrae to show rib articulation.

tuberculum. Reference to the complete skeleton will reveal that of these two projections, the tuberculum articulates with the transverse process of the vertebra, which is very short, and the capitulum with the centrum, or, more accurately, the point of junction of the centrum with that next in front of it. [A simple mnemonic for remembering this: C for capitulum articulates with C for centrum; T for tuberculum articulates with T for transverse process.]

In examining the single thoracic vertebra you will see that at each end of the centrum just below the neural arch

is a depression which would be contiguous with similar depressions on the centra of the vertebrae immediately in front or behind the one you are examining. Each of these depressions is termed a **demi-facet,** and into the cup-shaped depression formed by the juxtaposition of two demi-facets, the capitulum of the rib fits. When the rib is held in its position with respect to the vertebra, notice that there is a space, through which blood vessels could pass, between the fork formed by the capitulum and tuberculum and the body of the vertebra. The posterior three ribs do not have a tubercle. Each of the first seven ribs joins, on its ventral side, with the sternum (see page 57) and collectively the ribs form the bony cage which encloses the thoracic viscera. Note that the last three or four thoracic vertebrae differ in form from those anterior to them in that the neural spine is short and metapophyses are present.

Drawings.—Make a drawing of the lateral view of a thoracic vertebra, and also an end view together with the ribs.

Laboratory Note.—Make a note on the distinguishing features of the thoracic vertebrae, and on the difference in form of the anterior and posterior vertebrae.

Between the thoracic vertebrae and the base of the skull are found the cervical verte-brae. Of these, the first two are very specialised, so consider a typical one first. Again, the chief parts, **centrum, neural arch, neural spine**— which is short— **pre-** and **post-zygapophyses,** will be obvious, but the condition

Fig. 10.—Typical cervical vertebra. Left postero-lateral view.

of the transverse processes is peculiar and characteristic.

At the side of the centrum, just below the neural arch, is a hole which passes through the length of the vertebra, and outside which is a bony process. This hole marks the **vertebrarterial canal,** through which, as its name implies, the vertebral artery passes. This canal is formed by the fusion of the upper part of a reduced **(cervical) rib** with the **transverse process** and centrum. The greater part of what is apparently transverse process—and is often so-called—is therefore in reality a cervical rib fused on to the vertebra. [Compare the space which was formed between the proximal portion of the rib and the vertebra in the thoracic vertebrae.] Determine in your specimen how much is transverse process and the position of the fused cervical rib.

Drawings.—Make drawings of one face of a typical cervical vertebra and a dorsal view to show the relative positions of the transverse process and cervical rib.

Laboratory Note.—Make notes on the distinguishing features of a cervical vertebra.
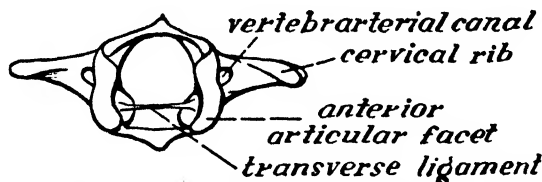
Fig. 11.—Anterior face of the atlas vertebra.

Next consider the specialised first and second cervical vertebrae. Examine the first one. This is, of course, articulated directly with the occipital region of the skull, and is called the **atlas*** vertebra. Note that it consists of a ring of bone, in which no centrum can be recognised, with a broad flange arising from each side. It is almost entirely neural arch, the centrum having been appropriated,

* This name comes from human osteology, and was given to the corresponding vertebra in the human spinal column because of the way in which this vertebra supports the " world of Man" (his head or skull) in the same way that the mythological figure, Atlas, was supposed to support the world on his shoulders.

as will be mentioned later, by the second cervical vertebra. Now orientate the specimen. On one face there will be seen two extensive concave articular surfaces. This is the anterior face. Observe also that the bony ring is much broader from back to front on one surface than it is on the other, where it is reduced to a narrow bridge of bone stretching from side to side of the vertebra. The broad surface is the dorsal surface. The **articular facets** on the anterior face form two deep depressions of which the dorsal margins project further forward than the ventral, and into these depressions the occipital condyles of the skull fit. The posterior face of the vertebra has two upwardly and inwardly facing articular facets for articulation with the second cervical vertebra and also on the inner ventral surface is a
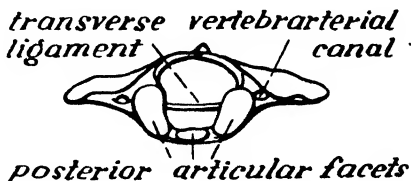
Fig. 12.—Posterior face of the atlas vertebra.

small facet on which the bony projection (the **odontoid process**) of the second vertebra rests. In the complete atlas vertebra, the space enclosed by the bony ring is divided by a transversely running ligament into an upper space in which lies the beginning of the spinal cord, and a lower space in which the odontoid process of the second vertebra fits.

Between the bony ring of the vertebra and the transversely projecting flanges will be seen the vertebrarterial canal.

From this it is evident that these flanges are really cervical ribs, though they are commonly called the transverse processes.

Drawings.—Anterior, posterior, and dorsal views of the atlas vertebra are instructive. Do not forget to indicate the position of the transversely running ligament, for even if it is absent in your specimen, the short projections on the inner sides of the vertebra can usually be seen.

Laboratory Note.—Make a list of the distinguishing features by which an atlas vertebra can be recognised.

The second cervical vertebra is called the **axis*** vertebra. It is really a composite structure, for the forwardly projecting tooth-shaped process (the **odontoid process** or **odontoid peg**), from the front of the centrum is regarded as the centrum of the atlas vertebra which has become separated from it and fused on to the centrum of the axis vertebra.
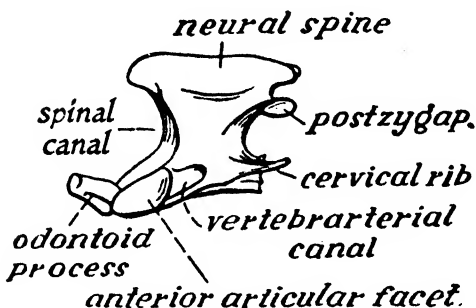
Fig. 13.—Axis vertebra, left side.

On each side of the odontoid process is an elongated articular facet. If you place the atlas and axis together in their correct positions you will see that these facets are in contact with the facets on the posterior face of the atlas, but are much longer. This allows the atlas to be rotated on the axis, the odontoid process serving as a pivot, and the transverse ligament in the atlas keeps the odontoid process in position.

On the posterior face of the axis vertebra, a pair of **postzygapophyses** are present for articulation with the **prezygapophyses** of the third cervical vertebra. The neural spine is flattened laterally and projects beyond the anterior and posterior ends of the spinal canal. At the sides of the centrum are the **vertebrarterial canals** with the fused cervical ribs.

* The origin of this name is that the atlas vertebra and the skull rotate upon the " axis " of the odontoid process in from side to side movements of the head.

Drawings.—The most instructive views of this vertebra are the lateral and anterior ones.

Laboratory Note.—Make a list of the distinguishing features by which the axis vertebra may be recognised.

Immediately behind the lumbar vertebrae are the **sacral vertebrae.** In this region of the vertebral column there has been considerable fusion between the individual vertebrae to give rigidity for the support (as will be seen later) of the pelvic girdle, and the fused vertebrae are often spoken of collectively as the **sacrum.** The sacrum is usually considered to consist of four vertebrae, of which the first three are always fused together and the fourth may or may not be fused. Of these vertebrae, the first* is much the largest,
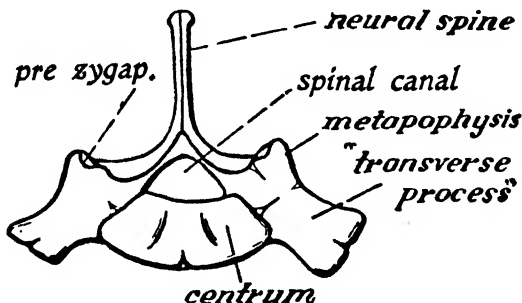
Fig. 14.—Anterior face of first sacral vertebra.

and in it the " transverse processes "† are widely expanded to form the wing-like processes at the sides to which the expanded portions of the ilia of the pelvic girdle (see Fig. 22, page 67) are ankylosed. Like the lumbar vertebrae, this vertebra has **metapophyses** at the sides of the prezygapo-

* Some authorities regard only the first vertebra as a truly sacral vertebra, and the remaining three as caudal vertebrae, but there are differences in all four from the caudal vertebrae which justify the view that they belong to the sacral region.

† These processes are regarded by some authorities as sacral ribs. Hence if the term transverse processes is used, it is well to put it in inverted commas.

physes, but they are much smaller in size. The **neural spine** is prominent and is much more vertical in direction than those of the lumbar vertebrae. Anapophyses and hypapophyses are not present. The underside of the centrum is flattened and has two prominent foramina through which the spinal nerves issue.

The second sacral vertebra is much more slender than the first, and tapers posteriorly. It has no widely expanded lateral wings, and only a small portion of its anterior lateral border articulates with the pelvic girdle. Small metapophyses are present and the neural spine is directed backwards. On the flattened ventral surface are two foramina, as in the first. The third and fourth are similar to one another, resemble more the ordinary caudal vertebrae, and have no direct connection with the pelvic girdle. The metapophyses have become progressively smaller, the neural spines less prominent, and the ventrally placed foramina are only clearly distinguishable on the third.

Drawings.—Draw the whole sacrum from the ventral and lateral aspects to show particularly the form of the first vertebra, and the surfaces which are in contact with the pelvic girdle.

Laboratory Note.—Make a list of the distinguishing features of the sacrum.

The fifteen or so vertebrae which form the caudal region of the vertebral column show a progressive reduction in their neural arches and transverse processes, until in the terminal ones little beyond the cylindrical centrum remains.

Laboratory Note.—Make a list of the characters of the caudal vertebrae by which they may be recognised. (It is scarcely worth while drawing these vertebrae.)

The Sternum

In the thoracic region of the body, the first seven vertebral ribs are joined ventrally by cartilaginous ribs with a medianly placed skeletal structure called the **sternum**. This consists of seven ossified elongated segments or **sternebrae** articulating with one another. The first, which is called the **manubrium**, is flattened laterally so that its

ventral surface is produced into a kind of keel. The second
to the fifth sternebrae are much alike, but the sixth is very
small, and is scarcely recognisable in the dried preparation
of the skeleton. The seventh is called the **xiphisternum**;
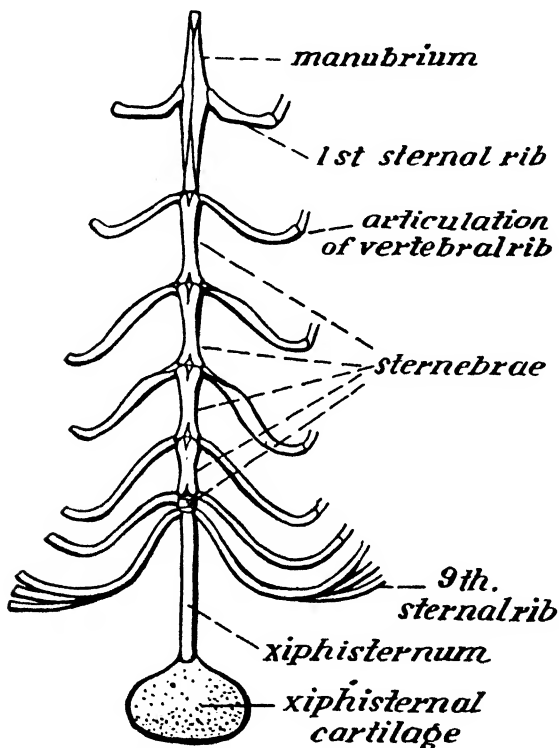
Fig. 15.—Ventral side of the sternum with sternal ribs.

it is long and slender, and terminates in an expanded
cartilaginous plate, the **xiphisternal** or **xiphoid cartilage.**
  To these sternebrae articulate the sternal portions of the
first seven ribs, forming the **sternal ribs** or **costal cartilages.**

The first pair join the manubrium at about half way along its length. The remainder articulate, in succession, at the junctions of the sternebrae.

Of the remaining five pairs of vertebral ribs, Nos. 8 and 9 are connected with the sternum only indirectly by means of the seventh rib; these two are usually called **false ribs.** The last three vertebral ribs have no connection whatever with the sternum and are spoken of as **floating ribs.**

To each side of the forwardly projecting front end of the manubrium is attached the ligament in connection with the clavicle (part of the pectoral girdle. See page 60).

Drawing.—Make a drawing of the sternum with the sternal ribs from the ventral aspect.

Laboratory Note.—Make a note as to which vertebral ribs are attached to the sternum and which are false and which floating ribs.

B.—THE APPENDICULAR SKELETON

The appendicular skeleton comprises the **fore** and **hind limbs** with their skeletal supports, the **pectoral** and **pelvic girdles,** embedded in the body. Primitively, the girdles were skeletal structures encircling the part of the body in which they were situated, but in the Eutherian mammals, to which the rabbit belongs, the pectoral girdle particularly has been much modified. In the limbs, all the long bones (humerus, femur, radius, tibia, etc.) during development ossify from three centres so that the adult bone consists of a central **shaft** or **diaphysis** at either end of which is an **epiphysis.** The sutures between these can usually be distinguished.

The Pectoral Girdle

As in all Eutherian mammals, the pectoral girdle has been reduced until it consists almost entirely of **scapula,** the name by which the half-girdle or **shoulder blade** is commonly known. This consists of a roughly triangular plate of bone upon which various processes are developed. Notice first its position in the complete skeleton. It lies,

apex downwards, with its long axis inclined at an angle to the axis of the body, in the dorso-lateral region of the thorax, on the outside of the ribs. It has no skeletal connection with the vertebral column and is, in fact, merely held in position in the living animal by the muscles in which it is embedded. Examine your specimen, and determine, by comparison with the complete skeleton, whether it is a right or left scapula. At the apex is a shallow depression, the **glenoid cavity,** into which the uppermost bone of the fore limb fits. This cavity is overhung by a hook-shaped process, the **coracoid process** or **coracoid spur,** which is all that remains of the coracoid bone of the primitive girdle. This process developed separately from the scapula, but later became fused on to it.

The **scapula** itself is a triangular sheet of bone. The anteriorly directed border, which arises from the coracoid process, is known as the **coracoid border;** the posteriorly direct-

Fig. 16.—The right shoulder blade.

ed one as the **glenoid border.** The shorter base of the triangle is, in the living animal, continued dorsally as a narrow sheet of cartilage, the **supra-scapula,** but in the dried bone this has usually disappeared. The outer surface of the scapula is thickened and produced outwards, a little anterior to the middle line, into a prominently projecting ridge of bone, convex in front and deeply excavated behind. This is termed the **spine,** and is continued as a projection, the **acromion process,** quite free from the blade of the scapula. Arising at right angles to

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the acromion is a spur of bone, the **metacromion process.**
The spine, acromion and metacromion processes serve for
the attachment of muscles. From these points you will
see how to determine whether your specimen is a right or
left scapula without reference to the complete skeleton.
In determining this, remember (1) that the glenoid cavity
points forwards; (2) that the spine is on the outer
side; and (3) that the metacromion process points down-
wards.

The **clavicle** (a membrane bone) is a slender elongated
bone connected at each end by a ligament to the manu-
brium of the sternum on the one side, and the coracoid
process of the shoulder blade on the other. It is so small
and insignificant that in the collection of loose bones it is
usually lost, but its position and form can be seen by
reference to the complete skeleton.

Drawings.—Make a drawing of the scapula from the lateral aspect,
and also a sketch of the glenoid cavity to show the overhanging
coracoid spur.

Laboratory Note.—Make a note regarding the separate origin of
the coracoid spur, and upon the position of the clavicle.

The Fore Limb

The skeleton of the fore limb is made up of the **humerus**
supporting the upper arm, the **radius** and **ulna** the fore-
arm, the **carpal bones** the wrist, and the **metacarpals** and
phalanges the fore paw.

First examine the limb in the complete skeleton in order
to establish the position in which it is held, a position
associated with the habits of the animal. When a rabbit
jumps, the fore limbs have to take the force of the impact
with the ground at the end of the leap, and during walking
movements, to support the weight of the front part of the
body and raise it above the substratum. In the primitive
tetrapod (four-footed) animals, the main axis of the limbs
was at right angles to the long axis of the body, with the
palmar surface of the hand (or foot) parallel to the sub-
stratum (the prone position). In order to raise the body,

the limb became flexed at the joint between the upper and fore-arm, the elbow, and at the wrist, thus:
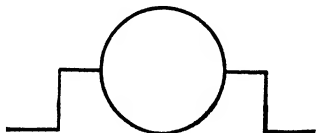
Fig. 17.

Now, to arrive at the present position of the fore limb in the rabbit the humerus has been turned backwards through 90° so as to bring its axis nearly parallel to that of the body, and at the same time, the bones of the fore-arm have been rotated upon one another through 90° so as to bring the back of the hand into the anterior position. Repeat this process on your own arm. When the arm is extended outwards from the body with the thumb upwards, the limb is in the primitive position with the preaxial border uppermost—that is, anterior in an animal walking on four legs. Now bend the arm forwards at the elbow so that the upper arm and fore-arm are at right angles, and then the wrist so that the hand points outwards. Now bring the elbow backwards and downwards into the side and at the same time rotate the wrist, and consequently the bones of the fore-arm, so that the back of the hand is uppermost (the prone position), and by comparison with the complete skeleton, you will see that your fore limb is now in the same relative position as that of the rabbit. Notice also that it is only the digits which are in contact with the ground—an example of a digitigrade limb.

Drawing.—Make a simple sketch to show the relation of the bones of the fore limb to one another in the normal position.

Laboratory Note.—Make a note on the way in which the position of the limb has been arrived at.

Next examine the bones in detail. The **humerus** consists of an elongated shaft of bone expanded at its proximal end into a rounded knob, the **head**, which fits into the

glenoid cavity of the scapula. Distally, the humerus tapers towards a broadened, rounded end which has a deep groove in it. These points will enable you to orientate the bone, but now you must determine whether it is a right or left humerus. At the proximal end the shaft is flattened from side to side so that the flattening is lateral.
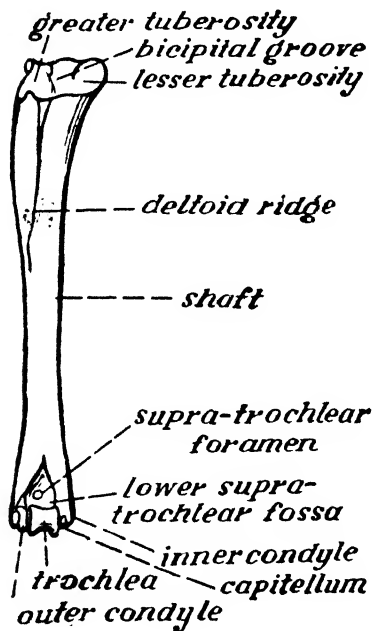
Fig. 18.—Ventral aspect of the right humerus.

On one edge of this flattened portion there is a distinct ridge, the **deltoid ridge.** If you now hold the specimen so that this ridge is directed ventrally you will have it in the position in which it is in the body. Looking along the shaft of the bone you will notice that the head projects more to one side—the side where it fits into the glenoid cavity. If, then, the head projects to the *right* (when the head is directed away from you), then the specimen belongs to the *left* side of the body, and *vice versa.*

At the sides of the head of the humerus are two knobs of bone, the **lesser tuberosity** on the inner side and the **greater tuberosity** on the outer side. In the rabbit, it happens that the lesser tuberosity is the larger of the two. Between these tuberosities is a groove (the **bicipital groove**) in which runs a strong tendon in relation with the biceps muscle. Notice that the head and tuberosities are developed from

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the epiphysis. Now examine the distal end. The deep groove, the **trochlea,** which extends around the end of the bone is shaped like the wheel of a pulley, and in it the articular surface of the ulna moves. On the inner side of the trochlea is a smaller groove, the **capitellum,** with which part of the radius articulates. At each side of the bone in line with the trochlea, is a projection, the **inner (internal) condyle** on the inner side, and the **outer (external) condyle** on the outer side. On the upper or dorsal side of the humerus, the groove of the trochlea passes into a deep, roughly triangular depression, the **upper** (posterior) **supra-trochlear fossa** or **olecranon fossa.** Into this depression the olecranon process of the ulna fits when the fore limb is straightened out. On the under side, there is a similar but shallower depression, the **lower** (anterior) **supra-trochlear fossa** or the **coronoid fossa.** These two fossae communicate with one another by a small aperture, the **supratrochlear foramen.**

Drawings.—Make drawings of the humerus from the dorsal and ventral aspects.

Laboratory Note.—Make a note of the way in which you determined whether your specimen was a right or left humerus.

lesser tuberosity
greater tuberosity
head
upper supra-trochlear fossa
supra-trochlear foramen
trochlea
capitellum
inner condyle

Fig. 19.—Proximal and distal ends of the right humerus from the dorsal aspect.

The **radius** and **ulna** are long, slender bones, closely applied to one another throughout their length and firmly adherent at their epiphysial ends. The ulna is readily distinguished from the radius because it is, the longer bone and projects beyond the point of articulation with the humerus to form the **olecranon process.** Remembering the position in which the fore limb is held, it follows that the bones of the fore-arm are fixed in the pronate position,

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and that the rabbit cannot rotate its fore paw in the same way in which we can our hand, a movement which involves the rotation of the radius around the ulna. Notice also that as the result of this position, the proximal part of the radius crosses over that of the ulna, so that, looking at the two bones from the front, the proximal end of the ulna lies behind the radius, whilst at the distal end they lie practically side by side. This will enable you to determine to which fore limb your specimen belongs. Still looking at your specimen from the front, it will be seen that the proximal end of the radius projects beyond the lateral margin of the ulna, and the side on which it projects is the outside of the limb. If, then, as you look at your specimen it projects in the direction of your *right*, then it belongs to the animal's *left*, and *vice versa*.

At the proximal end of the radius and ulna there is a deep notch, the **sigmoid notch**, into which the trochlea of the humerus fits. This notch is formed by both radius and ulna; near the proximal end of the ulna, below the olecranon process, the excavation is almost semi-circular in outline. Where the excavation is in contact with the head of the radius, articular surfaces are developed upon the latter. Note that the markedly convex articular surface within the excavation in the ulna is continued on to the radius. This convex surface forms a ridge which fits into the trochlea of the humerus. On the radius, at the outside of this ridge is a smaller articular surface which moves over the capitellar surface on the humerus.

Fig. 20.—Left radius and ulna from the right side.

Drawings.—The most instructive drawings are a lateral view of the two bones, and a front view of the proximal end.

Laboratory Note.—Make a note of the pronate position of the radius and ulna.

In the **carpus** or **wrist**, the **carpal bones** are arranged, as in the typical pentadactyl limb, in three rows; a proximal row of three, a centrally placed bone, and a distal row of four (really five, as the last bone is made up of two fused together). In the proximal row, two bones, the **radiale** (or **scaphoid***) and the **intermedium** (or **semilunar**) articulate with the radius, and the **ulnare** (or **cuneiform**) the largest in the row, with the ulna. The centrally placed bone, the **centrale** articulates with the middle portions of the distal surfaces of the radiale and intermedium. The distal row is made up of four bones of unequal size. The first, **carpale I.** (or **trapezium**) is small and articulates with the distal surface of the radiale. Do not confuse it with the much larger nodule of bone—a sesamoid bone†—which is found on the ventral surface of the wrist.

Fig. 21.—Carpals, metacarpals and phalanges of the left fore limb.

Carpale II. (or **trapezoid**) is smaller still and articulates with the radiale and centrale. **Carpale III.** (or **os magnum**)

* These alternative names come from human osteology, and are the names of the individual bones in the human wrist. It will be obvious that they have little significance except position in the rabbit. It is better to call the bones by their zoological names.

† Sesamoid bones are formed by ossifications in tendons attached to muscles.

is the smallest in the row and articulates with the inner part of the distal surface of the intermedium and with the inner surface of the centrale. **Carpale IV. and V.** are fused together to form the largest bone in the row, the **unciform** bone. They articulate with the distal surface of the ulnare. In addition to the true carpal bones there is on the under side of the wrist, articulating with the under side of the ulnare, a sesamoid bone called the **pisiform**.

The manus or hand is composed of five metacarpals and five digits. **Metacarpale I.** is very short and articulates with carpale I. **Metacarpale II.** articulates partly with carpale II. and partly with the centrale. **Metacarpale III.** articulates with the outer side of the centrale and the inner side of carpale IV. **Metacarpale IV.** and **V.** articulate with the remaining part of the distal surface of the fused carpale IV. and V.

Of the digits, the first or **pollex** is the shortest, and has two **phalanges**, whilst the other four have three each. The terminal phalanges are pointed and support the **claws**.

Drawing.—Make a drawing of the wrist and hand together from the dorsal aspect.

Laboratory Note.—Make a note on the points of difference between the rabbit's carpus and manus and the typical pentadactyl condition.

The Pelvic Girdle

In order to provide a rigid support for the hind limbs, the **pelvic girdle** is strongly developed, and, as has already been mentioned, is firmly ankylosed to the sacrum. Each half of the girdle, usually called the **os innominatum** or **innominate bone**, is made up of three chief bones, the **ilium**, **ischium**, and **pubis**, which meet in the region of the socket, the **acetabulum**, into which the head of the femur fits. Each innominate bone is roughly the shape of a " d " or " b " according to the side, and in the complete skeleton, you will see that it is inclined at an angle with the stroke of the " d " or " b," representing the ilium and ischium, uppermost, or dorsal. Now you can orientate your specimen

and examine the parts. The **acetabulum** is at once evident as a circular, deeply excavated socket from which the ilium projects forwards, the ischium backwards, and the pubis downwards. Between the ischium and the pubis is a large aperture, the **obturator foramen.**

The **ilium** is a stout bone which, immediately in front of the acetabulum broadens and becomes flattened and wing-like. On the outer surface of this wing-like portion is a ridge, while on the inner surface, just where it begins to
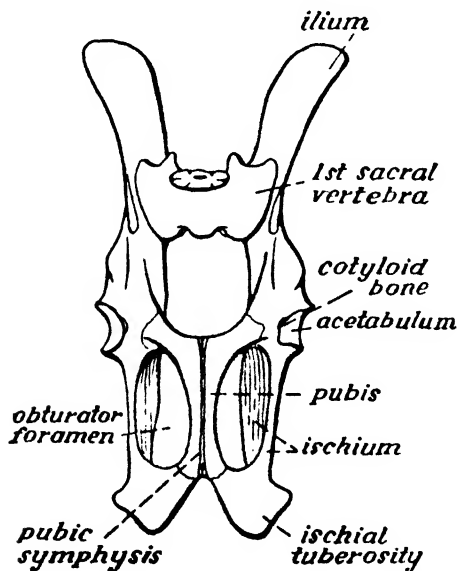
Fig. 22.—The pelvic girdle with the first sacral vertebra. Ventral view.

broaden, is a roughened horse-shoe-shaped surface for the articulation of the first sacral vertebra. In a young specimen, where the sutures are still evident, it will be seen that the posterior part of the ilium forms roughly the anterior half of the acetabulum. The **ischium** is also

narrow near to the acetabulum, but posteriorly widens into a blade-like extension which projects downwards and joins the pubis on the ventral side of the obturator foramen. At the widened end of the ischium, the bone is thickened to form the **ischial tuberosity.** On the dorsal side of the ischium is a strong spur of bone, the **ischial spine.** At the acetabulum the ischium joins the ilium on the dorsal side and forms the greater part, but not the whole of the posterior part of the socket.

The **pubis** is a flattened slender bone which passes downwards from the region of the acetabulum, though it does not contribute to its formation, and forms the antero-ventral margin of the obturator foramen, on the ventral side of which it joins the ischium. The two pubic bones meet together in the mid-ventral line at the **pubic symphysis.** The ventral part of the acetabulum is completed by a small bone, the **cotyloid** bone which ossifies separately from the pubis upon which it abuts.

Drawings.—Draw the complete pelvic girdle from the ventral aspect with the sacral vertebrae in situ; and also an innominate bone from the side.

The Hind Limb

The **hind limb** in the rabbit is specially adapted for its characteristic mode of progression by leaping. The impetus for each leap is provided by a powerful backwardly directed movement, which, since the foot is pressed against the ground, results in the forward propulsion of the body. In the normal position, as you will see in the complete skeleton, the limb is held with the thigh directed forwards, the shank backwards, and the ankle and foot forwards. (Compare with the fore limb.) When the animal is at rest, the under surface of the foot and ankle are touching the ground, but at the moment of leaping, only the digits of the foot remain in contact with the substratum. This specialised use of the limb is reflected in the skeleton, for in the shank region there has been fusion of bones to give rigidity, and in the foot only four digits are present, the first having been lost.

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The skeleton of the hind limb consists of the **femur** supporting the thigh, the **tibia** and **fibula** the shank, the **tarsal** bones the ankle, and the **metatarsals** and **phalanges** the hind paw. The **femur** consists of a shaft of bone with four projections at one, the proximal end, and a groove at the other, the distal end. The dorsal surface is slightly
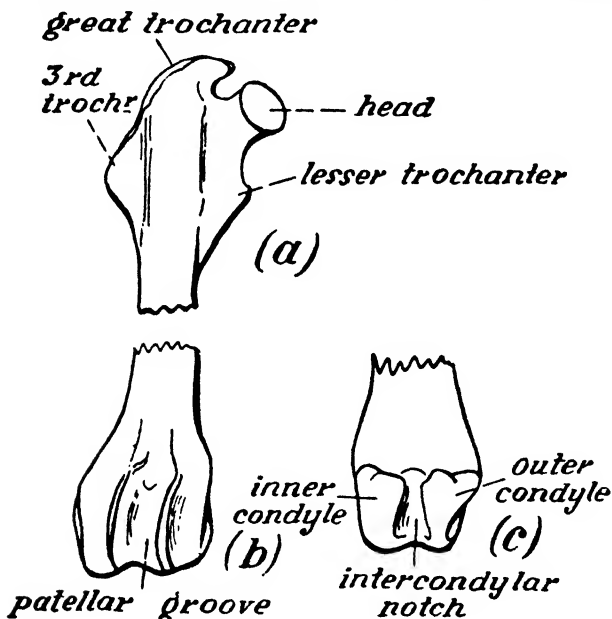
Fig. 23.—The right femur.

(a) Dorsal side of the proximal end.
(b) Dorsal side of the distal end.
(c) Ventral side of the distal end.

convex along the length of the bone, and the proximal end is flattened on the under side. Now orientate your specimen and determine to which side of the body it belongs. At the proximal end there is an obvious rounded projection, the **head**, which fits into the acetabulum of the pelvic

girdle, and is consequently on the inner side. Hold the bone dorsal side uppermost so that the proximal end is pointing towards you, and look along the shaft. If the head is on the *left* side of the bone as you look at it, then it belongs to the *right* hind limb, and *vice versa*.

In addition to the prominently projecting head, at the proximal end of the femur there are three other bony protuberances, termed **trochanters,** to which muscles are attached. The largest, projecting in the line of the main axis of the bone, is the **great trochanter,** on the outside of which is a smaller but quite prominent one, the **third trochanter.** On the inner side of the bone below the head is a small projection, the **lesser trochanter.** At the distal end of the femur is a groove which passes into a deep depression between two rounded articular surfaces, the **outer** and **inner condyles,** which articulate with the proximal end of the tibia. The shallow groove on the upper surface is the **patellar groove,** in which slides a sesamoid bone (the **patella** or **knee-cap**) attached to the tibia by tendon. [Quite frequently the patella remains attached to the tibia in the preparation of the dried specimen, but is always preserved in the complete mounted skeleton.] The patellar groove passes at its lower end into the **inter-condylar notch,** the deep depression you have seen between the two condyles. On the under surface of the distal end of the femur, close to the condyles, two sesamoid bones, the **fabellae,** are usually present.

Drawings.—A dorsal and ventral view of the femur will show all the essential points.

Laboratory Note.—Make a note of the points by which the orientation of the bone may be determined, and also by which you decided to which side of the body the specimen belonged.

In order to give rigidity to the shank, the **tibia** and **fibula** are partly fused together, and the fibula has become partly reduced. You will, therefore, have no difficulty in determining which is the tibia since it is the larger of the two bones. It now remains to orientate your specimen and determine to which side of the body it belongs. The tibia

is roughly triangular in section at its proximal end and tapers and then broadens at the distal end. The triangular section of the proximal end results in the development of a prominent ridge, the **cnemial crest,** which is on the anterior face of the bone. Holding the bone with the cnemial crest pointing towards you, it will be seen that the slender fibula lies to one side and slightly behind the tibia. If the tibia is on the *right*-hand side, then your specimen belongs to the *right* side of the body (and *vice versa*), since the fibula is on the outside of the tibia. The proximal end of the tibia is composed of a large epiphysis upon which are two shallow grooves which articulate with the condyles of the distal end of the femur. The slender fibula is completely fused at its distal end to the shaft of the tibia, but at its proximal end it is articulated by its marked epiphysis with the under side of the outer edge of the epiphysis of the tibia. At their distal ends, the fused tibia and fibula show a deep notch flanked on either side by articular surfaces for articulation with the proximal tarsal bones.
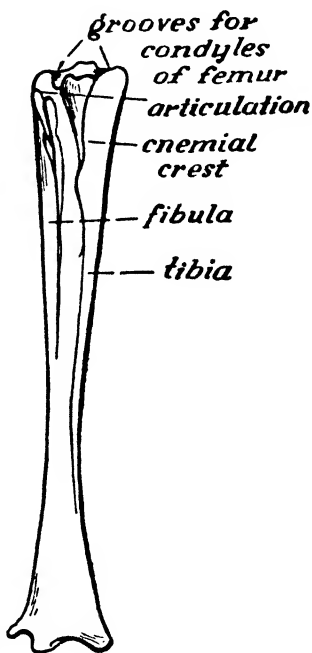
Fig. 24.—The right tibia and fibula from the anterior side.

Drawing.—An anterior view of the tibia and fibula will show all the essential points.

Laboratory Note—Make a note regarding the fusion of the two bones, and also the method of determining whether the specimen belongs to the right or left side of the body.

The **ankle** or **tarsus** is made up of six bones arranged, as in the wrist, in three rows, a proximal row of two, a centrally placed bone, somewhat displaced from its original position, and a distal row of three. It is evident from this that there has been some fusion among the tarsal bones, but this will become clear as the examination proceeds. Of the proximal tarsals the larger of the two (the **fibulare** or
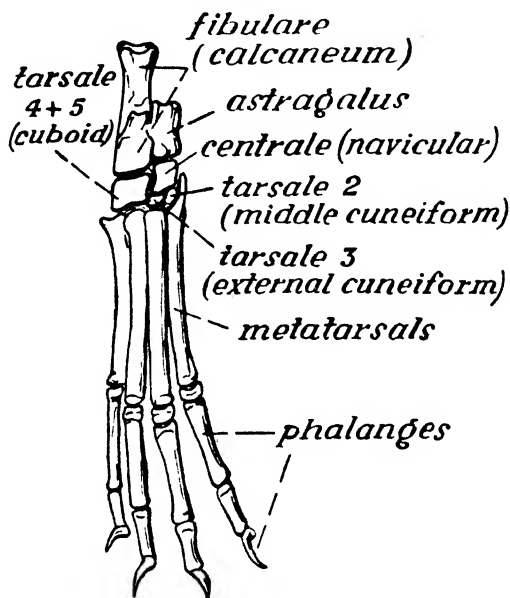
Fig. 25.—Tarsals, metatarsals and phalanges of the right foot.

calcaneum) has a backwardly projecting process, the **calcaneal process** or **heel** bone by which it is readily distinguished. The other, smaller, proximal tarsal is the **astragalus**, and the relative positions of these two bones will enable you to determine whether you are dealing with a right or left foot. As you will remember, the fibula is on the outer side of the tibia, so that looking at the dorsal

surface of the foot with the calcaneum and astragalus directed away from you, if the astragalus is on the *right-hand* side of the calcaneum, then the specimen is a *right* foot, and *vice versa*.

About half way along the length of the fibulare is a rounded knob with a grooved articular surface which articulates with the corresponding surface of the distal end of the fibular portion of the fused tibia and fibula. The astragalus is considered to represent the fused **tibiale** and **intermedium**. Its articular surface is at its proximal end and takes the form of a knob on which is a deep groove. If your specimen comes from the same limb, fit the tibia and fibula into position on the astragalus and calacaneum, and note how the articular surfaces fit together and permit the foot to be moved forward through a considerable arc, but that the backward movement is limited by the calcaneal process.

The **centrale** (or **navicular**) has been pushed on to the inner side of the tarsus so that it lies almost in line with the astragalus, though on its outer edge it is also in contact with the calcaneum. In a dorsal view, the centrale is roughly rectangular in shape, but on the under side of the foot it has a flattened distally projecting process which extends to the proximal ends of the second and third metatarsals, lying beneath the distal row of tarsals.

In the distal row of tarsals only three distinct bones are present. Associated with the loss of the first digit in the foot, **tarsale I.** (or **inner cuneiform**) is absent. **Tarsale II.** (or **middle cuneiform**) is the smallest of the three bones and articulates with the centrale at about the middle of its distal surface, the outer margin of the centrale being occupied by a projection from the outer side of metatarsale II. **Tarsale III.** (or **external cuneiform**) is larger than tarsale II. and articulates with the remainder of the distal surface of the centrale. **Tarsale IV.** and **V.** are fused together to form the **cuboid** bone which articulates with the distal surface of the calcaneum abutting on its inner margin with the centrale and tarsale III.

The metatarsals are four in number, viz. II. to V.

Metatarsale II. has, as has been mentioned previously, a projection* at its proximal end which abuts on tarsale II. Consequently, its proximal end articulates partly with tarsale II. and partly with the centrale. **Metatarsale III.** articulates with tarsale III., and **metatarsale IV. and V.** with fused tarsale IV. and V. **Metatarsale V.** has an outwardly directed spur at its proximal end.

The digits are also four in number, the first (**hallux**) having been lost. Each digit has three **phalanges,** the terminal phalanges being pointed and supporting a **claw.**

Drawing.—A dorsal view of the wrist and hand, will show most of the points you have observed.

Laboratory Note.—Make a note on the loss of the first digit, and the condition of the bones in the tarsus.

* This projection is variously regarded as (*a*) representing tarsale I., or (*b*) representing all that is left of metatarsale I.

EXTERNAL FEATURES

For general dissection, small immature rabbits not more than three months old are recommended.

[Before the animal can be set aside for preservation, it is essential that the gut be removed. It therefore follows that during the first period of work, the dissection must have progressed as far as is indicated on page 108. We realise that this will take several hours, and it is desirable that the time allotted to the first period should be sufficient to permit of this being accomplished].

The Hair

The most obvious external character of the rabbit is its covering of hair which, because it is soft and has a commercial value, is usually spoken of as fur. It is important to remember that the presence of hair on the body is a character of only those animals whose females suckle their young, *i.e.* mammals. The function of a hairy coat is to help in conserving the heat of the body, for it is of the greatest importance for the health of the animal that the temperature of the body should remain constant. In life, as you know, the body is warm to the touch, because the rabbit is a warm-blooded animal. Only mammals and birds are warm-blooded animals; apart from these two classes, the temperature of the blood of animals closely approximates that of their surroundings. Such hairs as form the body covering are said to be *generalised*, for they are all more or less similar except perhaps for colour; but some hairs are different from those of the general covering, different in form or function or both; they are special hairs, and so are spoken of as *specialised* hairs. Examples of these specialised hairs are the " feelers " or " whiskers " or, technically, **vibrissae**; they are stiff and strongly developed on the face, projecting freely outwards. They are sensory, and, because they are organs of touch, they come within the

category of tactile organs. Measure the length of " spread " or extreme reach of the vibrissae and compare this with the width of the body at its widest part; does the comparison suggest any purpose for the vibrissae when you remember the nature of the rabbit's retreat ? Eyelashes are also specialised hairs and are doubtless protective in function; note their exact position.

The **colour** of the hair in domesticated or tame rabbits is variable, and rabbits for dissection are usually of the domesticated kind. But in the wild rabbit, its dusty brown colour is an excellent example of protective coloration; so long as the animal remains still, its presence is difficult to detect. The striking white patch on the under side of the tail is not so easy to explain. The usual suggestion offered is that it is a signal to its fellows that departure is advisable, though such a signal would appear not to be deliberate on the part of the rabbit, but incidental. It would be interesting if you enumerate the *pros* and *cons* of this explanation in view of such points as the absence of a loud voice, whether the rabbit is gregarious or solitary in its habits, and the effect of the appearance of one or a number of bobbing white patches on a pursuing enemy like a dog. It is also interesting to reflect that the rabbit has held its own in the struggle for existence, not by its powers of aggression, but by the very reverse—its success in running away from danger.

The Head and Body

The **body** is divisible into head, neck, and trunk with limbs. This is, in general, characteristic of terrestrial animals; shoulders follow a neck, and shoulders would be a disadvantage to aquatic animals. Aquatic mammals, like the whale, have the neck or cervical region reduced to a minimum.

The **head** is elongated on account of the comparatively long snout. A prominent snout indicates a well-developed nasal region and a keen sense of smell. At the end of the snout is the **mouth**, which is peculiar. The aperture is

quite small. This may be associated with the animal's food and habits; it is a vegetarian and merely nibbles its food; there is no need for a wide gape for seizing prey, such as is essential in the case of a carnivorous animal like the cat or dog.

The **upper lip** is peculiar in that it is divided into right and left halves constituting what is known as hare-lip; the dividing groove is continued right and left to the nostrils, which are thus connected with the mouth. The **nostrils** are, when open, ovoid apertures just under the fleshy tip of the snout. On the inner side of each nostril is a foliated margin. Raise the tip of the snout and examine.
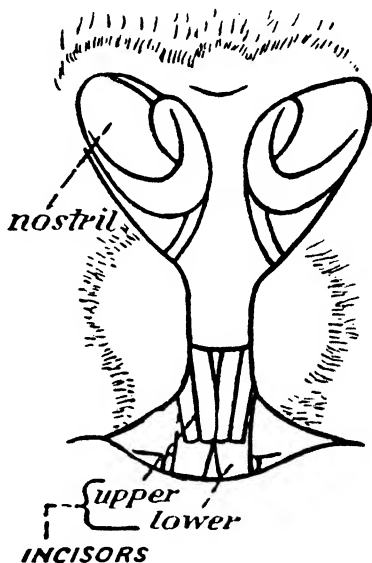
Fig. 26.—The mouth and nostrils with the tip of the snout raised.

The hare-lip exposes the front teeth or **incisors**, two on each side in the upper jaw and one on each side in the lower jaw. In the upper only one pair of incisors is visible from the front; these are the anterior incisors. Each has a groove down the middle, which gives the impression that there are two pairs visible. The posterior incisors are behind the anterior, and are very much smaller. An examination of the skull will make this clear. The chisel-like nature of the incisors is well adapted to clipping off vegetation. These teeth in the rabbit are peculiar in that they grow in length continuously and are kept at their normal length only by constant wear on one another; thus specimens are occasionally found in which

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an injury has caused a dislocation, resulting in the upper and lower incisors not being opposed to each other, and in consequence the teeth grow to a great length like tusks projecting from the mouth.

The **eyes** are prominent as would be expected in an animal so wary as the rabbit. Note the position of the eyes on the head and how this position compares with the position of your own eyes. Which would have the greater lateral range of vision with the head still, a rabbit or man ? Do you think the rabbit gets stereoscopic vision, *i.e.* is it able to include an object in the range of vision of each eye at the same time ? Some time, ponder a while on the results of the absence of stereoscopic vision, *e.g.* the ability to judge distance.

The movable upper and lower **eyelids** are provided with eyelashes. At the inner (anterior) angle of the eye, you will see the edge of a third eyelid or **nictitating membrane,** whitish, fairly thick, and capable of being drawn across the eyeball to remove any offending particle. Draw it across the eye with the forceps.

Note the parts of the eyeball that are visible. Ordinarily, the " white " of the eye is not visible until either the upper lid is raised or the lower eyelid drawn down. The "white" of the eye is the **sclerotic coat** which, over the front of the eye, becomes quite transparent and is there known as the **cornea.** Through the transparent cornea can be seen the coloured part of the eye, the **iris,** in the centre of which is the pupil. The size of these two last parts will depend upon the extent to which the iris is contracted; the broader the iris, the smaller the **pupil,** and *vice versa.* The iris is a muscular continuation of the **choroid coat** of the eyeball, and the pupil is a " window " in the iris at which the lens is placed. Over the whole front of the eye is a transparent continuation of the epidermis, called the **conjunctiva** which, of course, is scarcely distinguishable except inasmuch as it gives a glossy appearance to the eye. Moisture is produced by glands called the **lacrimal gland** and **Harderian gland,** and in addition to keeping the surface moist, this moisture

lubricates the eyeball to facilitate movement and washes away dust particles from the surface.

Take the upper eyelid in the forceps and roll it outwards. This will show in the posterior superior angle, *i.e.* the corner nearer to the ear, a pinkish body just beneath the surface. This is the lacrimal gland. To show the Harderian gland, take the edge of the nictitating membrane in the forceps and draw it out from the eye so as to be able to see into the angle beneath it; here, too, is a pinkish body, which is the gland. With a lens, the pink colour is seen to be due to the presence of minute blood vessels over the glands. Throughout your studies you will find that it is a general rule that pinkish or reddish organs owe their colour to the presence of blood vessels.

During the latter operation you will be able to note that the nictitating membrane has a thickened circular part which is concave to the surface of the eyeball.

The external ears, or **pinnae**, are very large. They are folded to form a funnel-like entrance to the **external auditory meatus**, the tubular cavity leading to the middle ear. The presence of pinnae is another feature which is found only in mammals.

The Trunk

The head is attached to the trunk by the **neck** or cervical region. The advantages of a neck are obvious; consider its usefulness to a rabbit in conjunction with the position of the eyes. The ease with which a rabbit can turn its head about is explained by a study of the joints between the vertebrae of the neck.

By feeling, you will notice that the trunk is divided into two parts, the anterior part, the chest or **thorax,** being comparatively hard, while the remainder of the trunk, the belly or **abdomen,** is quite soft. The hardness of the thorax is due, of course, to the presence of **ribs** and **sternum** or breastbone, which protect the vital organs of the thorax.

The mammary glands in the female open on four or five pairs of **teats** along the ventral surface. In young animals

and in males, they may not be readily distinguishable, but in older females they will be seen on parting the fur. If, however, they are not immediately visible, wait until the fur is removed a little later on, when they will be seen in both sexes. Only in mammals are mammary glands found.

The **anus,** the terminal aperture of the gut, is situated on the under side, at the base of the tail.

On each side of the anus and close to it, are the **perineal pouches.** These are a pair of depressions devoid of hair. In older specimens they show more clearly than in young, and are seen to be wrinkled on the surface and to have fairly distinct lips, on the anterior of which, towards the outer side, is a papilla. It is on this papilla that the duct of the perineal gland opens, the spot sometimes being marked by a dark speck. In young specimens, the area of the papilla is scarcely raised, but shows as a cream-coloured spot. The depression may contain a yellowish accumulation which is partly dried secretion. The secretion gives the distinctive smell to the rabbit and the perineal gland is therefore an odoriferous gland.

Just anterior to the anus is the **urino-genital aperture.** In the female the aperture is called the **vulva;** it is a longitudinal slit-like opening, and just inside its anterior end, *i.e.* on the ventral wall of the **vestibule,** is a small projection, rod-like in form, called the **clitoris,** an organ which is the counterpart of the penis in the male. In the male the urino-genital aperture is situated at the end of a cylindrical process called the **penis.** It may be that it is not immediately obvious, at least in young males, owing to its being retracted inside its sheath called the **prepuce,** and also on account of the presence of fur. Later on when the fur is removed, the organ will be easily seen. If the organ is held between a pair of forceps, the prepuce can be readily drawn back and the end of the penis is seen to project beyond it.

On each side of the penis is an elongated reddish raised patch, the **scrotum** or **scrotal sac,** which is a pouch of skin containing the male genital gland called the **testis.** The presence of scrotal sacs is a common character of mammals.

The Limbs

In studying the form of the limbs it is advisable to have before you a mounted skeleton of the rabbit. The two pairs of limbs, the fore and the hind, differ from each other externally mainly by their length and the direction of their comparable parts. You are familiar with the fact that the mode of progression in the rabbit is leaping; the hind limbs get a large grip on the ground and give impetus to the leap; they are therefore longer than the fore limbs, whose function in progression is to receive the impact after the leap. Notice that the " bend " of the limb is directed differently in each pair. The elbow is directed backwards and the knee forwards. Hence the upper arm while sitting has a backward direction, while the thigh points forwards. The fore-arm is directed forwards and the shank of the hind limb backwards. But the fore-foot is in line with the fore-arm—there is no angle at the wrist—while the hind-foot is bent sharply at the ankle with the shank, and set forwards.

(1) THE FORE LIMB. The three regions of the fore limb are readily seen—upper arm, fore-arm, and foot, with the wrist between the last two. The fore-foot has five **claws,** useful for excavating burrows.

(2) THE HIND LIMB. The three parts—thigh, shank, and foot—are less obvious in the hind limb, because the knee is well up against the body and does not appear. Do not mistake the backwardly directed ankle for the knee. The foot is long, and in sitting, lies flat on the ground; during leaping, however, the heel is raised. There are only four claws in the hind-foot, the absent digit corresponding to the great toe in man.

Drawings.—1. From your specimen draw the face of the rabbit from the front view to show lips, teeth, nostrils, and vibrissae.

2. Draw the eye and its immediate surroundings and label all the parts. Supplement this sketch by another to show the position of the lacrimal and Harderian glands.

3. Draw a diagram of the urino-genital region in, (*a*) a male, and (*b*) a female rabbit, labelling all the parts.

Laboratory Notes.—1. Make a list of the external characters of the rabbit which are characteristic of mammals.

2. Write out a list of external characters which would enable another person to conclude that they refer to the rabbit and no other animal.

3. Record together the length of the " spread " of the vibrissae and the width of the body at its widest part.

4. List the specialised hairs found in the rabbit.

5. Make a note of the number of incisor teeth in the upper and lower jaws, and the relative position of those in the upper jaw.

6. Write a note on the function of the lacrimal and Harderian glands.

7. Note down that the eyelids are movable. Also write a note on the nictitating membrane—shape, position, movability, and function.

8. Make a note of the means of distinguishing externally the thorax from the abdomen.

9. Write a remark on the function of the perineal glands.

Pin the animal down on the dissecting board with an awl through each wrist and with the arms stretched out. The awl should be fixed in a sloping direction, radiating from the direction of the centre of the animal. Similarly drive an awl through each ankle, so that the animal is firmly fixed. [French nails may be used instead of awls but they are less convenient; they require a hammer for fixing—a noisy procedure—and are extracted only with difficulty.]

Fig. 27.—The rabbit pinned out on a dissecting board.

Before beginning to remove the skin, you are advised to pluck off the fur from the abdomen. In old rabbits, however, plucking may be impossible. Plucking has several

advantages. It removes a source of annoyance caused by fur sticking to one's fingers and instruments during dissection; after the removal of the fur the teats of the mammary glands are very easily seen, even in young animals and in the adult male; finally, plucking makes the incision much easier as it enables one to see better where to cut, and so avoids accidents.

REMOVAL OF THE SKIN

At about the middle of the abdomen, pinch up the skin between your left thumb and finger, giving it a rolling action to make sure that nothing but skin and no body wall has been raised. Then cut transversely through the skin with the scissors, making a hole to enable you to insert your finger. Look inside the hole and notice the shining white **connective tissue,** which is areolar connective tissue, on all sides stretched between the skin and the body wall beneath, effectively attaching the two together.

Insert a finger and pass it round inside, particularly forwards, in order to break down the connective tissue attachment. Make a convenient clear area before cutting so as to prepare the way for safe cutting.

Make an incision forwards in the middle line so far as the connective tissue has been broken down. Continue this process until the incision has reached the base of the neck, making sure, by feel, that you have passed the first rib; then proceed in the same manner along each fore limb.

Next turn the dissecting board round so that the animal's head is towards you, and continue the median incision to the pubic region and down each leg to the foot.

Taking one side of the cut edge of the skin in the abdominal region by your left thumb and finger, raise it from the body wall and break down the connective tissue with your right finger where this is possible. In places, *e.g.* in the middle line, you will find the connective tissue very tough, and a scalpel will be necessary. When a scalpel is used, employ the back of the instrument in preference to the cutting edge, and break down the connective tissue **as**

close to the skin as possible. In this way remove the skin from the ventral and lateral sides, the arms and legs, and pin it down.

When the skin is spread out, the **vascular supply of the skin** is well shown. You will observe that on each side one system converges towards the armpit, and the other to the base of the thigh. Examining any part with a lens, you will notice that there are always two blood vessels accompanying each other—one rather darker and larger than the other; these are the cutaneous veins and arteries respec-

Fig. 28.—Breaking down the connective tissue between the skin and the muscular body wall.

tively, returning blood to, and bringing fresh supplies from, the heart. It is a very general rule that veins and arteries are in close company, though there are some exceptions, and it is always advisable to look for both vein and artery when studying the vascular system. The veins converging to the armpit join the subclavian vein; those entering the

body at the base of the thigh join the ilio-lumbar vein. The arteries are branches of the subclavian and ilio-lumbar arteries respectively. Note also the large vein and artery

Fig. 29.—The muscular body wall exposed.

alongside, on the inner surface—that facing you in the dissection—of the thigh; they are the **femoral vein** and **iliac artery** respectively.

The specimen will most probably afterwards be preserved for future work. It is desirable that the skin be removed from as much of the body as possible; however, leave the skin intact on the head and neck; this will preserve the neck structures from damage and undue drying. Make no attempt to remove the skin from the feet, but cut through the skin round the wrists and ankles.

[*The complete removal of the skin, except for that of the head, neck, and feet, may be effected after the first period's work.*]

Special care is necessary in the region of the armpit (**axilla**), where large blood vessels of the arm and skin emerge.

The muscular body wall will now be exposed. You will observe that it is comparatively thin and sufficiently transparent to show a considerable amount of the internal anatomy. By comparison with Fig. 32 identify as much as possible of the viscera.

Look for the following parts, but remember that your specimen may show things rather differently from the figure given. The **thorax** and **abdomen** are now very easily distinguishable. The soft abdominal area will be seen to be traversed by a number of areas distinguished from each other by colour, running obliquely backwards from the animal's right to left.

THE THORACIC WALL

Examine the ventral and lateral sides of the thoracic wall. Through the muscular covering you will probably be able vaguely to trace the ribs.

The Muscles

Some of the muscles associated with, or near to, the wall of the thorax are so obvious and striking that it will interest you to know what they are.

(1) The **pectoral muscle** is a large triangular sheet stretching from practically the whole length of the sternum

to the upper arm, across the shoulder. This powerful muscle draws the fore-leg towards the body and assists in burrowing.

(2) The **latissimus dorsi** muscle is a broad sheet of rather thin muscle covering the whole side of the thorax and passing over to the back and upper arm.
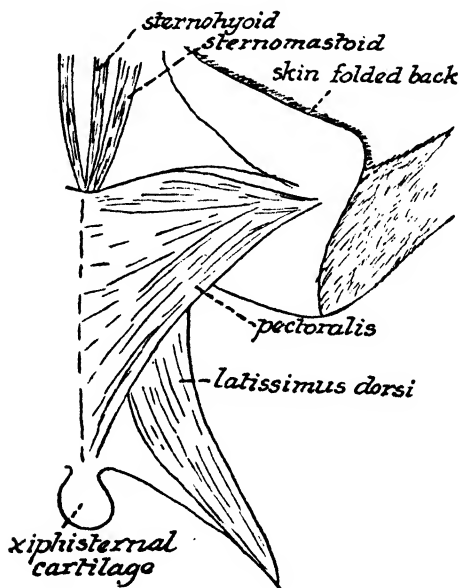
Fig. 30.—The principal large muscles of the thorax seen on the removal of the skin.

Remove the attachment of the pectoralis muscle on the sternum and that of the latissimus dorsi, and turn the muscles aside. This will reveal prominent muscles radiating from a point at the back a little removed from the thoracic wall; this point is the glenoid side of the suprascapular border of the shoulder blade. Examine a mounted skeleton of the rabbit and note the position of this angle.

(1) The **serratus magnus muscle** is the one whose several parts radiate like the fingers of a hand from the angle mentioned to the side of the thorax.

(2) The **rhomboideus muscle** runs from the same point on the scapula to the cervical vertebrae.

(3) The **teres major muscle** is the outermost of these muscles and goes to the upper arm.

Grasping these muscles either by the fingers or with forceps, pull them and find what action they bring about.
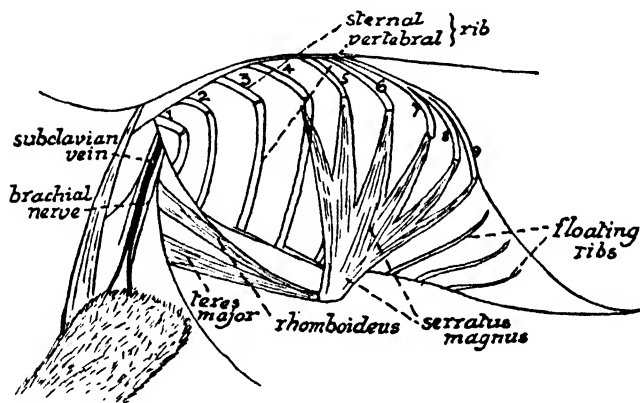
Fig. 31.—Side view of the thorax showing muscles attached to the scapula, and the ribs.

Drawing.—A figure of these muscles would be useful.

Laboratory Note.—Write a note on these muscles and their actions.

The Ribs

Having scraped the outside of the ribs, satisfy yourself of the number, form, and position of them.

In the first place note the junction of the **vertebral** (bony) and **sternal** (calcified cartilaginous) **portions** of each

rib. The junction is usually very marked, often being reddish at the end of the vertebral portion.

The last rib which has a connection with the sternum is the 9th, though strictly speaking its connection with the sternum is only secondary, as the cartilaginous ribs of Nos. 7, 8, and 9 have a single attachment which seems legitimately to belong to the 7th rib and is shared by Nos. 8 and 9 which are often called **false ribs.** Verify this by counting and feeling with the handle of a scalpel. Compare also with the mounted skeleton. No. 1 will be just in front of the large blood vessels and nerves which emerge from the anterior end of the thorax to pass along the arm.

The **floating ribs,** usually three in number, are to be seen in the thicker muscle wall behind the 9th rib and near the dorsal side. They are called floating ribs because their distal ends have no skeleton connection.

The Sternum

In the **sternum,** locate the **xiphisternal cartilage,** the posterior termination of the sternum, continuous with the rather long **xiphisternum.** In front of this is the series of six **sternebrae,** the first of which, the most anterior, is called the **manubrium.** The manubrium is in front of the 2nd rib; to its anterior end the **clavicles** of the shoulder girdle are attached, and mid-way along it the first ribs are attached.

THE ABDOMINAL WALL

The wall of the abdomen is muscular; down the mid·ventral line is a narrow strip of muscle, often lighter in colour than the rest; this is the abdominal rectus muscle. The others are known as oblique muscles; their fibres take an oblique course.

Immediately behind the last rib which is attached to the sternum, you will most probably see a dark mass showing through. This is the **liver,** the most anterior organ in the abdominal cavity. Sometimes, but not always, next the liver a distinctly whitish area shows through; this is the

stomach. Next in succession is a pinkish area, seen to consist of many coils; this is the small **intestine.** Sometimes this is the most anterior area observable, since the small intestine frequently coils over the stomach. The large obliquely directed areas remaining are the coils of the **caecum** with the **colon** in the middle.

Drawing.—Make a drawing of what you can actually see and prove the faithfulness of your drawing after you have opened the body cavity.

Laboratory Notes.—1. Write a note on the plucking of the fur from the abdomen, and the position and number of the teats shown.

2. Write a note on the cutaneous arteries and veins and the position of the femoral vein.

OPENING THE ABDOMINAL CAVITY

The limits of the thorax and abdomen are clearly defined. The thorax is encased by the ribs and the abdomen by the soft muscular body wall. With the fingers, pinch up the muscle in the mid-ventral line, making quite sure that body wall only is raised, and snick through it with the scissors. The greatest care must be taken to cut through nothing but body wall.

Lift up the body wall free from any underlying **viscera,** and insert the blade of the scissors; as soon as the point of the scissors has made an opening and air is admitted, the body wall will part company with the underlying viscera at once, making the cutting of the body wall an easy matter. But in no case make a cut until the viscera and body wall are separate.

Make an incision forwards in the middle line to a little short of the xiphisternal cartilage. There will then be no danger of piercing the diaphragm. Similarly continue the incision backwards to the pubes.

Then from the anterior end of the incision, cut through the muscle parallel to, and about a quarter of an inch (or half a centimetre) away from, the last rib. Do not injure the diaphragm, and most of all, do not pierce the stomach or intestine.

The flaps of muscular body wall may now be turned back and fixed, when the abdominal viscera will be exposed.

You will have noticed that the inner surface of the deflected body wall, the surfaces of the various organs, and the dorsal body wall all present a highly polished appearance and reflect the light like glass. This polished surface is due to the fact that the body cavity and all the viscera contained therein are covered with a smooth membrane called the **peritoneum.** The peritoneum has the property of secreting moisture on its surface. This moisture is highly important since it acts as a lubricant and allows organs adjacent to one another, or to the body wall, to move readily with the least friction. Any changes in size or position of organs is thus readily accommodated. You will shortly realise how easily different parts of the alimentary canal slide over one another.

The peritoneum forms a continuous sheet over the inside of the body wall and the viscera, but we distinguish that part on the body wall as the **parietal layer** of peritoneum, and that which surrounds the organs in the body cavity as the **visceral layer.** The part passing from the dorsal body wall to the intestines is called **mesentery;** mesenteries act as suspensories for the intestines and as a medium by which blood vessels and nerves are conveyed. Those parts which pass between the stomach, liver, duodenum, and spleen are spoken of as **omenta.**

THE ABDOMINAL VISCERA

You will at once be struck by the fact that all the organs of the abdomen which are visible before disturbance are disposed obliquely from right to left, *i.e. your* left to right.

You have opened a large cavity, the abdominal cavity; but the chest still remains closed. The two cavities, the abdominal and thoracic, are separated by a partition called the **diaphragm,** which you will examine more closely later on. Now the presence of a diaphragm separating abdominal and thoracic cavities is a feature only of that class of animals known as mammalia; it is therefore important as a distinguishing character.
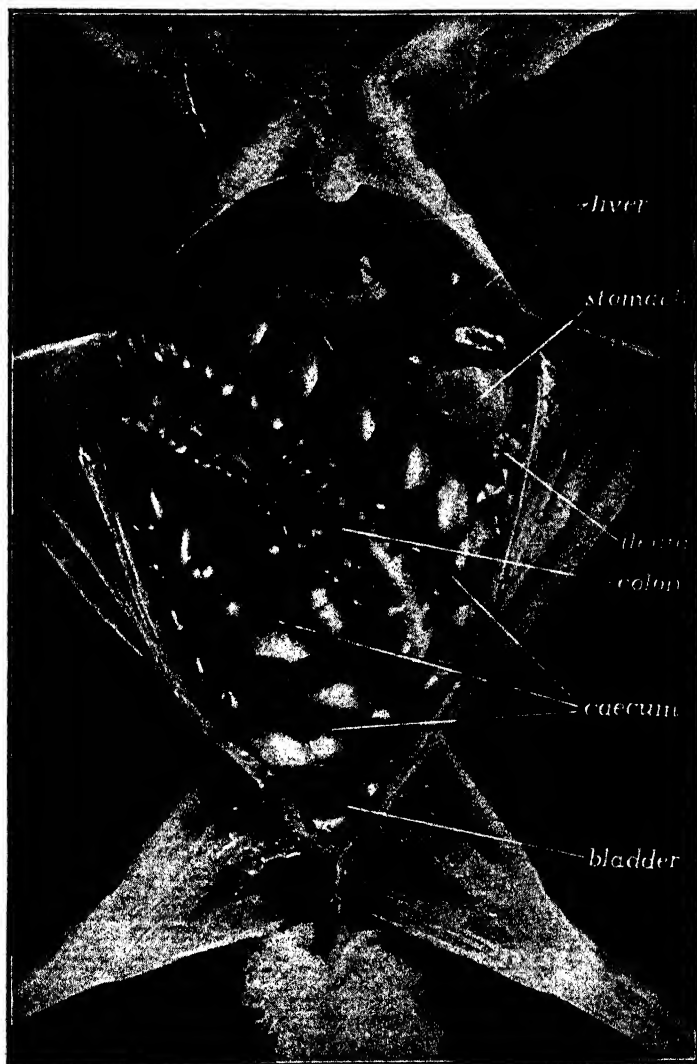
Fig. 32.—The abdominal viscera exposed.

Identification of the Organs in Situ

Identify the organs *in situ*. At the extreme anterior end of the abdominal cavity is the **liver**, a large, lobed organ, red in colour. Sometimes the liver entirely covers the **stomach**, but usually the stomach is visible in part as a large whitish sac stretching right across the body cavity. It is curved in form with its convexity on the posterior side, and it is wider on the left than on the right.

At the posterior end of the stomach—to the animal's left —you will probably see many of the small coils of the small intestine called the **ileum**, but most of the intestines are covered by two parts of the gut, viz. the **caecum** and the **colon**. The colon is readily distinguishable by its central position right across the body and by its smooth central part with small sacculations on each side. In front of the colon is one coil of the caecum, and behind, two coils. The great size of the caecum with its spiral constriction, is characteristic of vegetable feeders among mammals. It is likely that nothing else but alimentary canal is visible. At the extreme posterior end of the abdomen, the **bladder** may be visible; its prominence will depend on the volume of its contents; if it is empty, it will scarcely be visible.

Drawing.—Inside an outline of the trunk, make a drawing of the viscera *in situ*, now checking your previous drawing.

Laboratory Notes.—Write a note on the presence of the peritoneum and its functions. Make a note also of the names of the parts of the peritoneum.

After the gut has been disturbed, students frequently have difficulty in finding their way about the very lengthy alimentary canal. The difficulty will largely disappear if the colon and caecum are recognised, and also if it is remembered that the **sacculus rotundus** will be found immediately below (*i.e.* dorsal to) the place where the colon is continuous with the caecum towards the posterior end of the body. Raise this part of the gut and find the pale-coloured globular sacculus rotundus.

Try and realise how the parts of the gut are related to one

another. Look at Fig. 39, page 108, of the unravelled alimentary canal. You will see that at the region of the sacculus rotundus, three parts of the gut meet, (1) the distal end of the ileum, (2) the proximal end of the caecum, and (3) the proximal end of the colon. Shortly you will see that the termination of the colon is continuous with the rectum; the ileum is a continuation of the duodenum which leaves the stomach. The order, therefore, is stomach, duodenum, ileum, (caecum), colon, rectum.

Identification of the Parts of the Gut

Now for the identification of all the parts of the gut. You have already recognised the caecum, the colon, the sacculus rotundus, and the stomach.

Before disturbing the coils of the gut, consider the **caecum** a little more closely. Carefully note its orientation —which is the beginning and what direction it takes. It begins at the sacculus rotundus, and you know where that is. In the position you first see it, the caecum starts from the posteriorly placed end of the colon, then curves forward to the animal's right, parallel with, and immediately behind, the colon. On reaching the right side of the body, it doubles back on itself and reaches the posterior end of the body cavity, where it sweeps round up the left side and across the body again, parallel with, but immediately anterior to, the colon. Here it bends underneath (dorsalwards) and ends in the **vermiform appendix**. The appendix is thus situated on the right side. Raise the first loop of the caecum and find the appendix—a long, finger-like organ of pale colour strongly contrasting with the very dark colour of the caecum.

Move the caecum and colon with it over to the animal's right (your left) and find the **rectum**. It is easy to identify, since it will be found to contain, at intervals along its length, the faecal pellets like widely distributed beads on a string. Trace it as far back as possible, near the anus. At about 3 inches (7½ cm.) from the end, you will find that it is attached by mesentery to another coil of the intestine, creamish in colour and well supplied with blood vessels.

This is the ascending loop—distal arm—of the **duodenum.** To prove which is the proximal and which the distal arm —for the duodenum is a single loop—hold on to the part which is not attached to the rectum and, turning over the viscera, trace this limb to the stomach.

Fig. 33.—The caecum turned over to the right, exposing a coil of the rectum. Note the veins which are all part of the anterior mesenteric vein. The arteries are less prominent, but can nevertheless be recognised alongside the veins.

That part of the stomach from which the duodenum arises is called the **pyloric end,** and the constriction marking the division between the stomach and the duodenum is

Fig. 34.—The duodenal loop and pancreas.

called the **pylorus**. The opposite end of the stomach is spoken of as the **cardiac end,** and it is into this part that the **oesophagus** opens; the actual opening is called the cardia, hence the name given to this part of the stomach.

With particular care spread out the duodenal loop as shown in the figure. A piece of black paper placed under the loop will show things up better. Between the arms of the loop the **pancreas** will be seen as a diffuse, irregular, slightly pinkish body, the " sweetbread." The substance of the pancreas is particularly aggregated round the blood vessels. Examine the duodenum with a lens and note how richly it is supplied with blood vessels—arteries and veins.

The **pancreatic duct** opens into the distal arm of the duodenum at about the place where the mesentery connects it with the rectum, or about one-third the way up the distal limb from the bend; a lobe of the pancreas runs straight to the place. Holding up the duodenum slightly on the stretch, insert a pair of fine scissors and slit it up along the side opposite to the entrance of the duct. Clean away its contents, flatten out the duodenal wall, and you will see that the pancreatic duct opens on a fairly prominent reddish papilla on the inside of the duodenum.

To see the **bile duct,** turn the stomach over to the animal's left, so as to expose the pyloric end and the beginning of the duodenum. On the dorsal (under) side of the somewhat expanded commencement of the duodenum, the bile duct will be seen as a whitish duct running transversely across the duodenal wall to a mesentery between the pyloric end of the stomach and the liver for about ¾ inch (or about 2 cm.). It then passes between the lobes of the liver and joins the **gall bladder.** Contributory ducts from the lobes of the liver will be seen entering the bile duct.

The internal opening of the bile duct in the duodenum is on a pale papilla, which can be seen after slitting up the duodenum in that region and washing out the contents.

Note the **spleen,** a long, dark red body, against the posterior cardiac end of the stomach. It is described as a " ductless gland " concerned with both the breakdown and replacement of corpuscles in the blood.

Vascular Supply of the Gut

You will be obliged to take notes, as you proceed, of the parts of the vascular system, since arteries and veins will be destroyed when the gut is removed. Reference will frequently be made to the two principal blood vessels of the trunk, viz. the **posterior** (inferior) **vena cava** (postcaval vein) and the **aorta.** Both these vessels traverse the whole length of the trunk from the heart backwards, and both lie
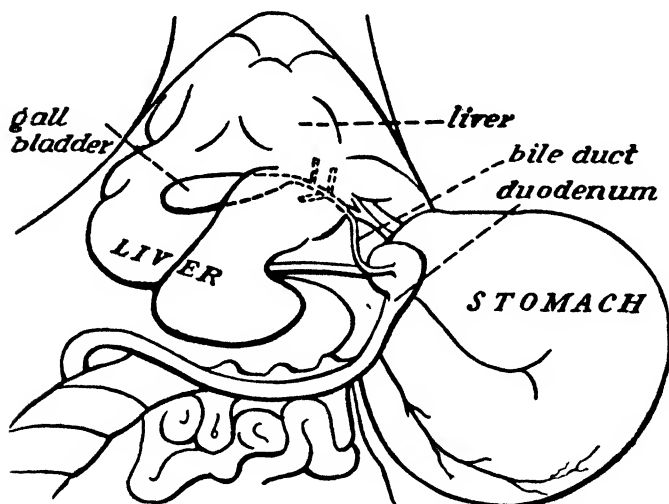
Fig. 35.—The course of the bile duct.

close together in the mid-dorsal line, the posterior vena cava being, in the main, ventral to the aorta. In the abdomen these great vessels are to be found quite close to the dorsal body wall, the aorta being somewhat obscured by the posterior vena cava and the peritoneum covering both vessels. No attempt should be made at present to remove the peritoneal covering; it is sufficiently transparent to show the aorta and its principal branches. Later on, the

peritoneum can be peeled off, but in the fresh specimen the operation is rather delicate.

Make a preliminary survey of these two vessels and note that they are found behind (dorsal to) the liver, then between the kidneys, and, at the posterior end of the body, both fork to participate in the vascular supply of the hind limbs.

Note the **duodenal vein** and its tributaries passing through the substance of the pancreas and receiving tributaries from the walls of the duodenum. This vein can be traced to the **portal vein.** Examine also the **duodenal artery** and its branches. With a lens, you will be able to see that the arteries and veins everywhere run side by side, the artery pale and the vein dark. Note the innumerable tiny vessels penetrating the pancreatic substance. The duodenal artery is a branch of the **anterior mesenteric artery** which you will examine later.

You must have noticed also that beautiful network of blood vessels supported by mesentery and serving the walls of the caecum. See Fig. 33. A lens will reveal a double set of vessels, dark coloured vein and pale artery. The veins appear dark because their walls are thin and transparent compared with the more muscular coat of the arteries. It would be useful if you keep this point in mind and look for arteries as well as veins everywhere; the few exceptions will then be more striking and easily remembered.

The veins in the mesentery just referred to form part of the **hepatic portal circulation,** as does the duodenal vein, and contribute towards the **anterior mesenteric vein**—the superior mesenteric vein of human anatomy—which collects blood from almost the whole of the intestine, and joins the great portal vein which goes to the liver.

The arteries which accompany the small veins are the finer branches of the **anterior mesenteric artery.** However, —note the exception—the main artery parts company with the vein and is found to arise from the dorsal aorta near the left kidney. (See Fig. 36.)

Trace the anterior mesenteric vein to the portal vein,
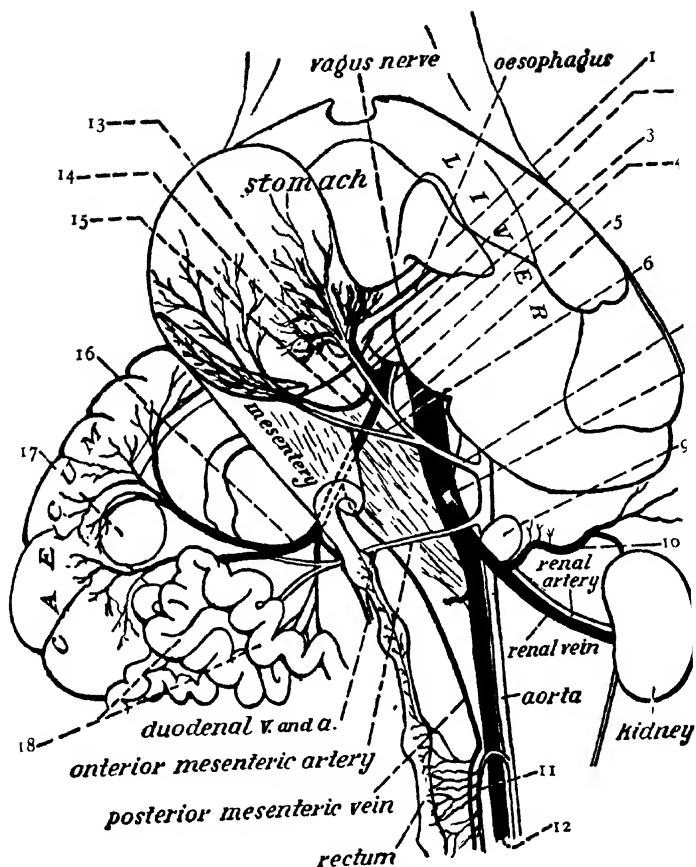
Fig. 36.—The vascular supply of the alimentary canal.

1. Spigelian lobe
2. gastric vein
3. lieno-gastric vein
4. hepatic artery
5. gastro-hepatic artery
6. lieno-gastric artery
7. coeliac artery
8. solar plexus
9. adrenal body
10. dorso-lumbar vein
11. posterior mesenteric artery
12. posterior vena cava
13. gastric artery
14. portal vein
15. splenic vein
16. anterior mesenteric vein
17. sacculus rotundus
18. ileum

which breaks up into innumerable branches, just like an artery, in the substance of the liver. Note particularly this peculiarity about the portal vein—it is built up by tributaries at one end from the intestine and breaks up into branches in the liver at the other end. Most veins join larger ones which go eventually to the heart without breaking up into branches before reaching it.

The portal vein is made up of the following principal tributaries: anterior mesenteric vein, posterior mesenteric vein, duodenal vein and lieno-gastric vein. All these principal tributaries, except for the lieno-gastric vein, join at approximately the same place, though variations often occur. The lieno-gastric vein comes from the stomach and spleen, as its name implies, the duodenal from the pancreas and duodenum, the posterior mesenteric from the end of the rectum, and the anterior mesenteric from the rest of the gut.

It will now be convenient to look for the **posterior mesenteric vein** and **artery**. Find the end of the rectum, passing beneath (dorsal to) the bladder to the anus. Move the rest of the gut over to the animal's right. Note that the vein coming from the posterior end of the rectum runs forwards near the middle line to the right of the very large vein—the posterior vena cava; this is the posterior mesenteric vein, which unites with the anterior mesenteric vein and duodenal vein to form the portal vein. By raising the duodenal loop, the posterior mesenteric vein may be seen joining the portal vein.

Looking carefully at the posterior part of the posterior mesenteric vein, you will see, running with it, an artery, the **posterior mesenteric artery**. This artery, supplying the posterior rectum, accompanies the vein only for a short distance, for it leaves the great median artery of the body, the dorsal aorta, towards its posterior end before the aorta forks for the supply of the hind limbs. Trace the artery to the dorsal aorta.

One important tributary of the portal vein remains to be examined—the **lieno-gastric vein**, made up of the **gastric vein** which comes from the wall of the stomach, and the
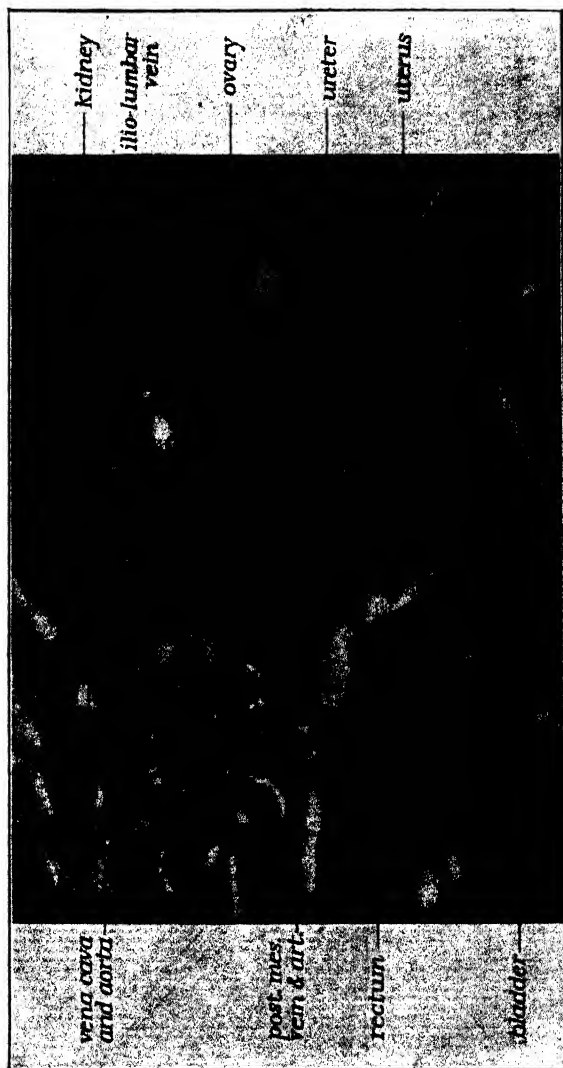
Fig. 37.—The distribution of the posterior mesenteric vein and artery.

kidney

ilio-lumbar vein

ovary

ureter

uterus

vena cava and aorta

post. mes. vein & art.

rectum

bladder

splenic vein from the spleen, that dark red body lying close to the cardiac end of the stomach. Having traced this vessel you will have completed the examination of the portal system. By removing the gut, the parts of this system are destroyed; you are therefore advised to make careful notes and good diagrams as a record of your study.

Along with the lieno-gastric vein, you will see arterial branches over the stomach and supplying the spleen. These are branches of the **lieno-gastric artery.**

Lift up the cardiac end of the stomach and turn it forward and to the right side of the animal so as to expose the spleen and the large blood vessels spread over the wall of the stomach (*i.e.* the dorsal wall). Considerable mesentery (omentum) will be seen here. It will be necessary to break down all mesentery hindering freedom of movement, but especial care must be taken *not to cut any blood vessels.* Find the **coeliac artery,** leaving the aorta just behind the diaphragm and then, to trace all branches, break down the mesentery *between* the vessels. The **oesophagus** will be seen appearing from between the lobes of the liver and joining the stomach; note the position of the union.

Both coeliac and anterior mesenteric arteries will now be very clear. At about ⅝ inch (1·6 cm.) from the aorta, the coeliac artery divides into (1) the **gastro-hepatic artery** and (2) the **lieno-gastric artery.** The gastro-hepatic artery is the more anterior one, and after a course of about ½ inch (1¼ cm.) it divides into the gastric branch which supplies the wall of the stomach near the oesophagus and the end of the oesophagus itself, and the hepatic branch to the liver. The **lieno-gastric** artery is the posterior branch of the coeliac artery and supplies the stomach and the spleen.

You should note that only the veins from the alimentary canal, *i.e.* of the portal circulation, become dissociated from their corresponding arteries; in all other cases, except for the hepatic vein and artery, vein and artery run courses practically parallel with each other. There is an important reason for this. The blood from the walls of the food channel, loaded with food in solution, also contains impuri-

ties which cannot be dealt with in the lungs. It is therefore necessary that before such blood reaches the heart—and from the heart to the lungs and back—it must undergo treatment. This treatment is effected in the liver. Here, by chemical change, harmful excretory substances are made innocuous, bile, partly an excretory product, is secreted, the sugar content of the blood is regulated, and urea is elaborated. Hence the necessity for the blood from the food channel to be passed through the liver before it is discharged into the posterior vena cava to reach the heart, and hence the different course of the blood in the portal circulation.

The Solar Plexus

It is usual, before removing the gut, to examine the **coeliac** and **mesenteric ganglia** (**coeliac plexus** or **solar plexus**) as these ganglia are difficult to see when broken mesentery has accumulated in that region. Push all intestines over to the right side of the animal. Find the **kidneys,** back against the dorsal body wall. Between the kidneys which, you will notice, are unsymmetrically placed, the right being in advance of the left, you will see the posterior vena cava and aorta side by side. Just about where the **renal vein** from the left kidney joins the posterior vena cava, you will see a small round, cream-coloured body, the left **adrenal body.** (See Figs. 36 and 38.) Leaving the aorta a little in front of the adrenal body is the anterior mesenteric artery. Near the adrenal body, the rectum is attached by a mesentery; this mesentery should be broken down while holding up the rectum.

Now a very close examination of the place where the anterior mesenteric artery leaves the aorta may reveal two stellate whitish bodies with fibres radiating from them. These are the ganglia constituting the solar plexus. They are sometimes difficult to find, but the application of a little acetic acid followed by strong alcohol to the spot will often assist in showing them up. Quite frequently, however, the solar plexus is found as a single ganglionic mass on the ventral surface of the posterior vena cava in the

same vicinity (see Fig. 36). The plexus is the termination of the **splanchnic nerve,** part of the sympathetic nervous system, arising from ganglia in the thorax. Take the opportunity of seeing the nerve joining the ganglia, passing forwards close to the aorta. This part of the sympathetic system will be examined later.
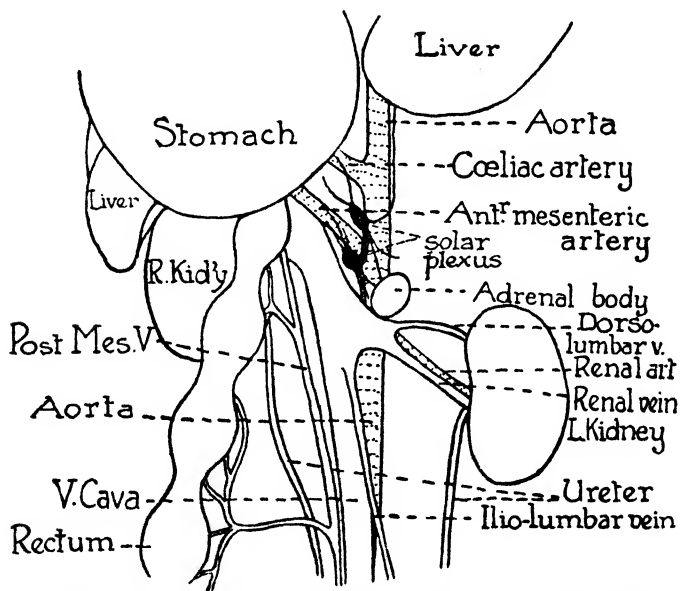
Fig. 38.—Diagram to show the usual position of the solar plexus.

Drawings.—1. Make a drawing of the viscera to show the vascular supply of the various parts you have studied. Insert also the position of the solar plexus.

2. Make separate sketches to show the duodenum with the bile duct and pancreatic duct, and also their internal openings in the duodenum.

Laboratory Notes.—1. Make notes of the methods you adopted to display the parts of the portal circulation.

2. Make a special note of your method of demonstrating the solar plexus.

REMOVAL OF THE GUT

With the fingers, lift the rectum near its end. Note that it is attached to the mid-dorsal line by a mesentery in which the posterior mesenteric artery and vein pass to and from this part of the rectum. The ultimate mid-dorsal suspension of the gut is best seen here.

Move the viscera over to the animal's right. Cut across the rectum near its end and, holding it up, cut through the mesentery connection as close to the gut as possible, so as to sever only the smaller blood vessels. You cannot avoid some loss of blood, but the loss will not be serious if you keep close to the gut when cutting. Throughout be careful not to puncture the caecum. Revise as you proceed.

Having freed about 10 inches (25 cm.), you will see the great portal vein passing beneath (dorsal to) the stomach and receiving its large tributaries. Identify these tributaries again. Then move the viscera over to the animal's left side (your right) and continue to unravel the gut. Alternatively, you may find it equally convenient, on reaching the stomach, to move only the stomach over to the left to continue the unravelling. Measure the length of the rectum when unravelled, and make a note of it; in a young rabbit, it will be about 21 inches (53 cm.) long. Note that it is distinguished by its contents, the faecal pellets, at intervals along its length. The next part to be unravelled is the colon, which is readily distinguished by its form; the puckerings are called **sacculations** and the smooth " cord " is called the **taenia**. The circular muscles of the colon are not complete, but are terminated at the taenia, which is a band of longitudinal muscle. If the taenia were stripped off, the sacculations would disappear. Measure the length of the colon; it will probably be about 12 inches (35 cm.) long. Record its length.

For further unravelling, the gut needs to be continually turned over. Care is necessary near the sacculus rotundus, and it cannot be too often repeated that the wall of the caecum especially must not be torn, for if it is, it may be quite impossible to continue work on the animal !

Try and keep the duodenal loop intact. Record the length of each part of the gut. Cut through the oesophagus after having measured its length from the back of the head. Then lay out the whole gut on a dissecting board. (See Fig. 39.)

The animal may now be preserved for further study.*

Fig. 39.—The alimentary canal unravelled.

Drawing.—Make a diagram of the gut as laid out on the dissecting board, labelling all parts.

Laboratory Notes.—1. Make a note of the lengths of the various parts of the alimentary canal, and the total length.

2. Write a brief note on the method of removal of the gut.

THE REMAINING ORGANS OF THE ABDOMINAL CAVITY

You can now proceed to examine the remaining organs of the abdominal cavity and their vascular supply.

* Before the animal is put into preservative, the skull should be trephined to admit preservative to the brain. For method, see page 165.

Posterior Blood Vessels

The two prominent ridges, one on each side of the middle line throughout the length of the dorsal body wall in the abdomen, are the **psoas muscles,** strongly developed in association with progression by jumps. Feeling the crests of these ridges you will feel the ends of the transverse processes of the lumbar vertebrae which thus actually form the crests. At the sides of these ridges, feel for the anterior ends of the ilia of the pelvic girdle; in the female, they will be found at the level of the ovaries and, of course, in a corresponding position in the male.

Between the ridges referred to above, examine those two great median blood vessels of the trunk, the **posterior vena cava** (inferior vena cava or postcaval vein) and the **aorta,** both of which pass along the whole length of the abdominal cavity. For the greater part of its length the posterior vena cava covers the aorta, but at its posterior end the aorta comes into view, and its right posterior branch lies ventral to the posterior vena cava.

First consider the posterior parts of these vessels. This means the termination of the aorta, which is distributing oxygenated blood, and the origin of the posterior vena cava, which is collecting deoxygenated blood and taking it to the heart.

The aorta will be seen to divide into two branches, the **iliac arteries** (or common iliac arteries), one to each hind limb. In their turn the iliac arteries branch, giving off three principal vessels. First are the **ilio-lumbar arteries** supplying the muscles of the dorsal body wall; they arise from the iliac arteries very near the point where these vessels leave the aorta and pass outwards. Next, just a little farther back, from the dorsal aspect of the iliac artery, is the second branch, the **internal iliac artery**; at present you will only see its origin, for it passes backwards close along the dorsal side of the pelvic cavity behind the large veins in this region. Later on, when the pelvic cavity is opened, you will find that it turns outwards and dorsalwards, leaving the pelvic cavity to run along the back of the thigh. Finally there is the **vesical artery,** originating

from the iliac artery near to the origin of the internal iliac artery. It is easily traced to the bladder, over whose surface it sends innumerable branches.

Each of the arteries just considered has a corresponding vein to return the blood from the organs supplied by the
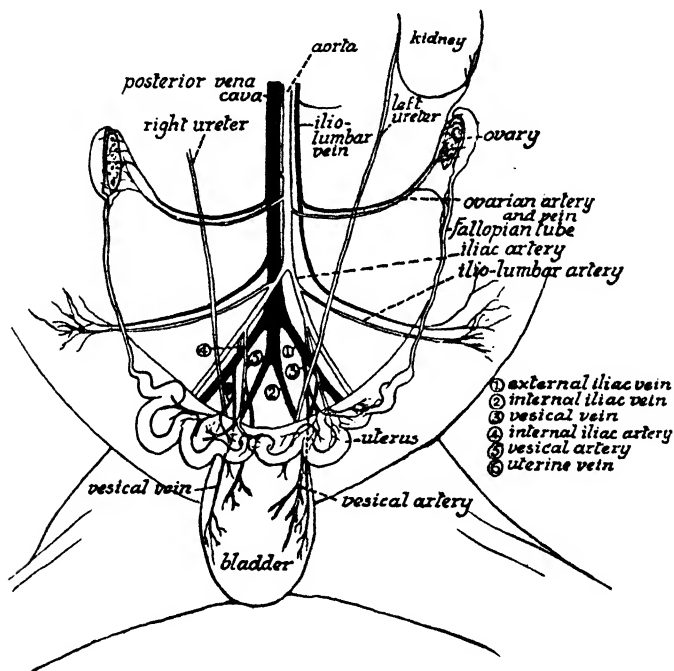
Fig. 40.—Posterior vascular system in the female. The bladder and uteri have been drawn back.

arteries. Thus there are the two great **external iliac veins** returning blood from the hind limbs; they are the direct continuations of the **femoral veins**, which you have already seen running along the inner sides of the thighs (page 86). Each external iliac vein receives a **vesical vein** from the

surface of the bladder, passing quite near to the vesical artery. At the back of the pelvic cavity are the **internal iliac veins,** which have come from the back of the thighs; if you look at the back of the thigh, you will see this vein at the surface of the muscle near the posterior border. Unlike their corresponding arteries which branch from the iliac arteries, they do not join the external iliac veins, but unite in the middle line actually to form the origin of the
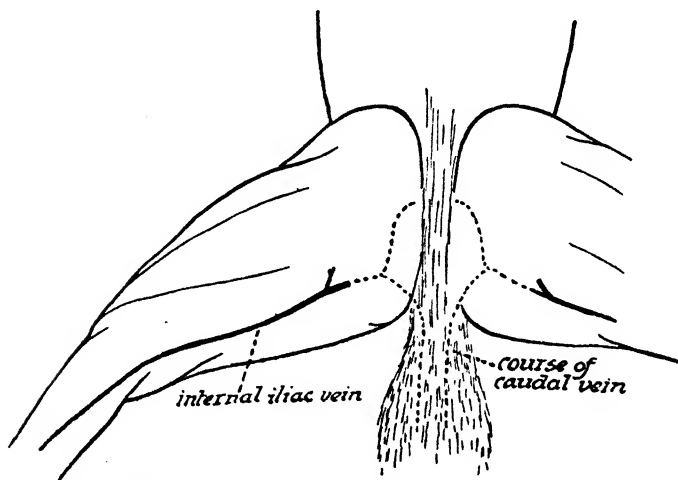
Fig. 41.—The back of the thigh with the skin removed to show the course of the internal iliac vein.

posterior vena cava. Corresponding to the ilio-lumbar arteries are the **ilio-lumbar veins.** On the right, the ilio-lumbar vein joins the posterior vena cava where one would expect—posteriorly in the vicinity it has drained. But on the left side variations occur. It may follow a course similar to that of its fellow on the right (see Fig. 53), but, quite as frequently, it bends forward and runs some distance parallel with the posterior vena cava and close to it before joining it; and it may, indeed, avoid direct union with the

posterior vena cava and unite with the renal vein from the left kidney.

Drawing.—Inside an outline of the animal, draw a diagram of the vascular system—arteries and veins—in the posterior portion of the abdomen. Allow for an extension of the diagram as far as the diaphragm.

Laboratory Note.—Make a note of possible variations in the positions of vessels.

The Gonads

Note the general position of the gonads. In the male, note the **testes** contained in their **scrotal sacs.** From the anterior end of each is a cord-like structure running forwards. This is the **spermatic cord** made up of an artery, a vein, and a nerve bound together by peritoneum. The cord passes into a canal—the **inguinal canal** close to the testis. The blood vessels are the **spermatic artery** and **vein** or genital artery and vein for the vascular supply of the testes.

Follow them forward and note that they are very closely associated until they approach the aorta and posterior vena cava respectively. The places where the spermatic arteries leave the aorta and the veins join the posterior vena cava are not usually quite symmetrical. The rest of the reproductive system will be dealt with later.

In the female, find the **ovaries.** They are small, ovoid bodies close against the dorsal body wall; the ovary on the left side is a little posterior to the kidney, and the left one symmetrical with its fellow. Note that the ovary and its duct are suspended from the dorsal body wall by a sheet of peritoneum. The ovary is supplied with blood by the **ovarian artery,** which passes out from the aorta at about the same level as the ovary. Alongside the ovarian artery is the **ovarian vein,** which, on the right, joins the posterior vena cava direct, but on the left it more usually joins the left ilio-lumbar vein. But look for variations here.

In this region, you might locate the stump of the posterior mesenteric artery, whose course you have already

studied (see page 102). Its position varies, being sometimes in front of and sometimes behind the origins of the genital arteries. Of course, no trace of the corresponding posterior mesenteric vein will be found, since it was entirely removed with the gut; but you will remember that it did not join the posterior vena cava, but joined the portal vein to the liver.

The Excretory Organs

The renal organs include the **kidneys,** their ducts called the **ureters,** the **bladder,** and the **urino-genital duct.** These constitute what is known as the renal system; however, the skin and the liver also have excretory functions.

The dark red **kidneys** are found closely attached to the dorsal body wall, and unsymmetrically disposed, the right being in advance of the left. Note their bean-like shape and the indentation on the inner side called the **hilus.** At this point the blood vessels enter and leave the kidney, and, in addition, the delicate whitish **ureter** emerges and runs posteriorly to the bladder.

Each kidney receives its blood supply from the aorta by the **renal artery,** and the return vessel, the **renal vein,** joins the

Fig. 42.—Longitudinal section of the rabbit's kidney.

posterior vena cava. The vein is much more prominent than the artery, but both vessels run side by side. The **dorso-lumbar vein,** seen just in front of the kidney on the left side, joins the renal vein before this vessel connects

with the posterior vena cava; it drains the muscles of the dorsal body wall. Its corresponding artery, the **dorso-lumbar artery,** runs exactly parallel with it, and joins the aorta. On the right side, these vessels are more or less symmetrical with those on the left, and therefore pass dorsal to the kidney instead of in front of it.

Make a median longitudinal section of the kidney passing through the hilus. To do this, take a large and very sharp scalpel so as to make a perfectly clean cut, and slice off the exposed surface as far as the hilus. It may be even better to use a razor. Examine the surfaces exposed. The bulk of the body of the kidney is the central part known as the **medulla;** the outer part is called the **cortex.** You will see that, at the hilus, the ureter expands into a small chamber which receives the tubules of the kidney; this chamber is called the **pelvis** of the kidney. Projecting into the pelvis is the **pyramid,** on which the tubules open.

The ureters should be followed to the bladder where they will be seen to enter on the dorsal side, each by a separate opening. Note that the ureters receive their vascular supply from the genital vessels.

The **bladder** may be quite small or very large, according to the degree of dilatation. This means that the wall of the bladder is very elastic. When large and distended, it needs careful handling to avoid rupture. The duct to the exterior is the urethra.

At the anterior end of the left kidney, an **adrenal body** will be seen; the right adrenal body is hidden by the kidney and the posterior vena cava, and to find it, it is necessary to release the right kidney from its peritoneal attachment to the body wall. These adrenal bodies are cream-coloured and are known as ductless glands, since no special adrenal duct conveys the product of secretion to the blood. They receive their vascular supply from the renal vessels.

Drawings.—1. Draw a diagram of the renal system with its vascular supply.

2. Draw a figure of a longitudinal section of the kidney showing the cortex, medulla, pyramid, pelvis, ureter, and blood vessels.

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The Liver

With the gut removed the liver can be examined in detail. It is a large, deep-red organ consisting of five lobes. In the freshly-opened animal, the greater mass of the liver is seen to lie close to the diaphragm. On its posterior side, it is in contact with the stomach. One lobe, however, is only slightly in contact with the diaphragm, and overlaps the right kidney, having a deep concavity fitting closely over the anterior part of the kidney. This lobe is called the **caudate lobe.** The smallest, and central, lobe is spoken of as the **Spigelian lobe.** The other three lobes are named according to their position, viz. **right central, left central,** and **left lateral lobes.** The **gall bladder,** a reservoir for storing bile, is situated between the right and left central lobes, more particularly in the right central; it is of deep green colour, and its duct, the **cystic duct,** as you have already seen (page 98) leaves it at its posterior end, and receives subsidiary ducts from the various lobes of the liver. The bile duct thus formed enters the duodenum a little beyond the pylorus and on the dorsal side.

Now consider the vascular supply of the liver. You will recall that the gastro-hepatic artery, a branch from the coeliac artery, sends its hepatic branch to the liver (page 104); this constitutes its arterial supply. You will also remember (page 100) that the great portal vein brought to the liver the venous blood from the walls of the alimentary canal. It now remains to study the conveyance of blood from the liver to the posterior vena cava.

By drawing back the liver from the diaphragm, you will see that it is attached to the diaphragm by a median peritoneal fold called the **falciform ligament** which envelops the whole organ. It is in this fold that the hepatic veins lie. [You have noticed that blood vessels are never loose in the body cavity, but run along folds of peritoneum, like the mesentery of the gut.] Break down this fold with great care so as to free the liver completely and push the liver over to the left side; the **hepatic veins** from the lobes of the liver will then be seen as short, thick vessels joining the posterior vena cava which is closely surrounded by the liver,

Drawing.—Make a drawing to show the lobes of the liver, indicating the gall bladder and its duct, the diaphragm, and the right kidney partly covered by the caudate lobe.
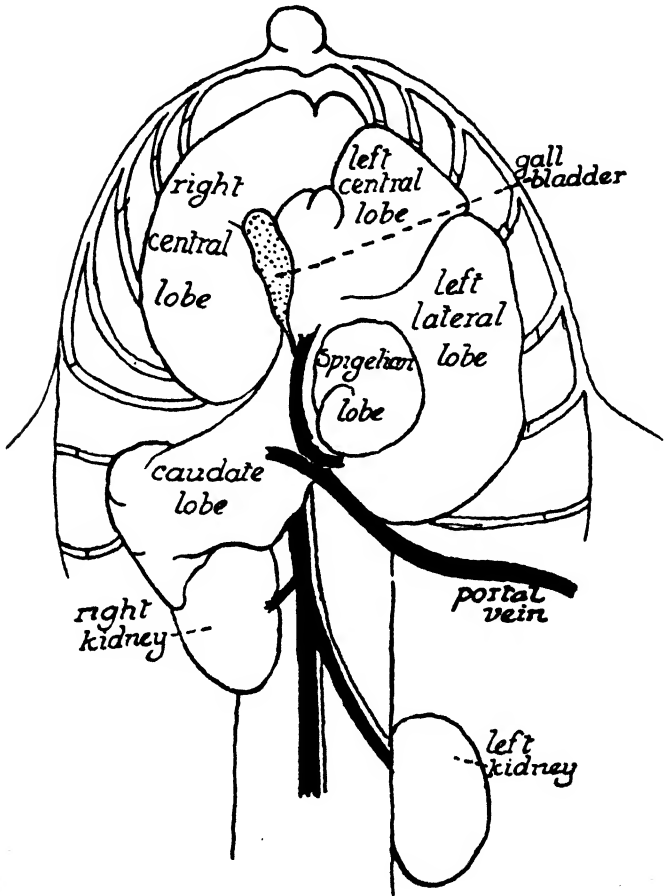
Fig. 43.—The lobes of the liver.

Phrenic and Lumbar Vessels

In the diaphragm note the **phrenic veins,** formed by many tributaries converging from all parts of the diaphragm, joining the posterior vena cava close to the diaphragm. Look for the corresponding artery and trace it. It is small, and arises from the aorta close to the diaphragm.

At intervals along the aorta and on its dorsal aspect is a series of seven **lumbar arteries;** along with them are **lumbar veins** from the posterior vena cava. The most posterior of these vessels arise just before the aorta forks into the two iliac arteries. They are median vessels which divide to serve dorsal muscles. To expose them, it is necessary to remove the peritoneal covering which lies over the posterior vena cava and the aorta. This peritoneum should be removed with great care with a small scalpel, cutting a short distance from the great vessels on one side, and peeling it off. The vena cava and the aorta will then stand out clearly, and by pressing the aorta gently to one side the lumbar vessels will be seen. Along with the last lumbar artery, often as a branch from it, is another median artery which runs posteriorly. This is the **sacral (caudal) artery,** and the continuation of this vessel can be followed after opening up the pelvic cavity. The **sacral (caudal) veins,** one on each side of the dorsal side of the tail, join the internal iliac veins (see Fig. 41).

Drawing.—In your previous diagram of the posterior vascular system, insert the renal, lumbar, and sacral vessels.

Sympathetic Nervous System in the Abdomen

You have already studied the solar plexus and its radiating system of nerves fibres. The paired sympathetic nerve cords, which are in connection with the solar plexus, are situated near the middle line and are covered by the aorta. Move the aorta to one side and you will see the very delicate nerves with slight swellings (ganglia) near the lumbar arteries and veins. At the origin of the posterior mesenteric artery, the **posterior mesenteric ganglion** will be seen. Move the artery to the right, and lying over its

origin is the ganglion with many nerves forming a plexus. Trace the system right through the abdomen. Later, you will follow the nerves into the thorax and neck.

Drawing.—Draw a diagram showing the position of the posterior mesenteric ganglion and the sympathetic nerve cords.
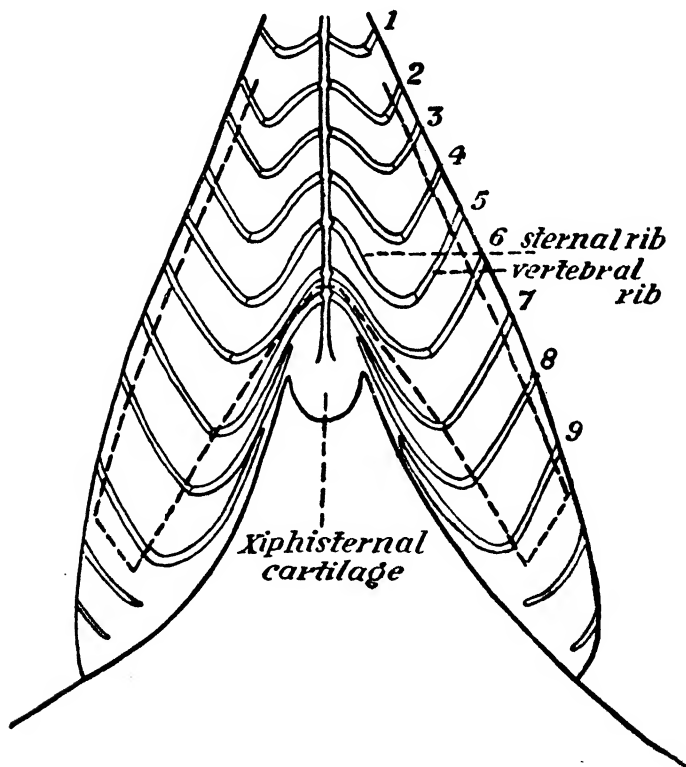
Fig. 44.—The thoracic wall. The broken line indicates the incision for the removal of the thoracic floor.

DISSECTION AND EXAMINATION OF THE THORAX

Your object is to remove the floor of the thorax to expose the organs and leave the diaphragm intact.

The Dissection

It will greatly assist you and provide for greater safety if you first scrape away the muscle at the hind edge of the thorax to expose the surfaces of the last two sternal ribs.

With strong scissors cut through the last sternebra (*i.e.* the 6th, counting the manubrium as the first) between the last two sternal ribs. Then continue the cut between the sternal ribs as far as the junction of the vertebral and sternal parts of the 7th rib. Do this on both sides. With the forceps, draw back the xiphisternal cartilage; you can then see into the gape and also see where to cut safely so as to avoid the diaphragm.

Looking inside the thoracic cavity: cut as far as through the 9th rib. Continue somewhat transversely behind the 9th rib and then forwards, cutting through all but the first rib: this will leave about ¾ inch (2 cm.) of ribs standing. If you have followed these instructions, you will have felt the scissors cutting through eight ribs (9th to 2nd). Do the same on the other side.

You are now ready to free the floor of the thorax. To do this, lift up the posterior margin of the thoracic wall and, looking inside the cavity, cut with fine scissors or scalpel as closely as possible to the ribs and sternum and detach any connective tissue attachments. None of the thoracic viscera will then be injured. Note the median peritoneal fold from the ventral wall as you cut it away.

Before you cut across anteriorly, examine the inner side of the thoracic wall. You will see on each side of the sternum a vein and an artery; you may need a lens to distinguish the artery properly though the vein will be clearly seen. To the vein come tributaries and from the artery go branches along each side of each rib. Note these vessels carefully, because when you remove the thoracic

wall these, too, will be removed. They are the **internal mammary vein** and **artery**. The vein joins the anterior vena cava (superior vena cava or precaval vein) and the artery arises from the subclavian artery.
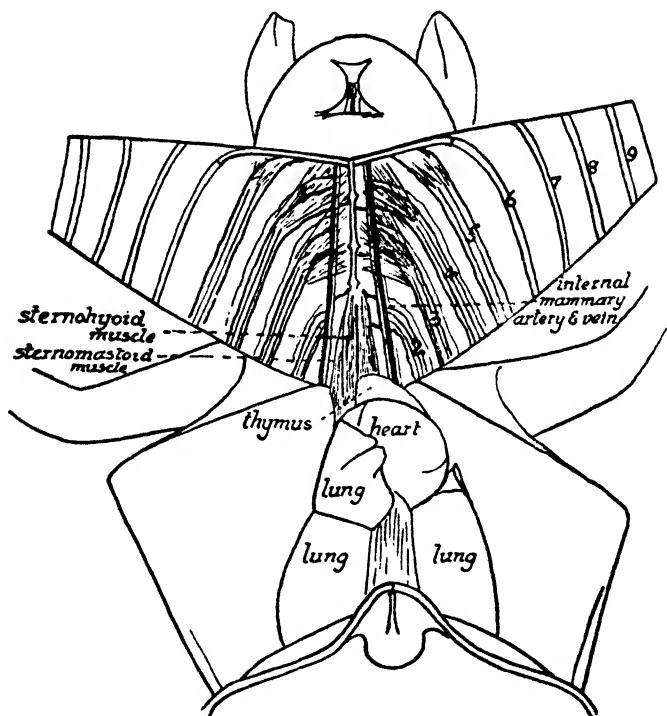
Fig. 45.—The inner side of the floor of the thorax.

Incidentally, the sternebrae can be studied very easily from the inner surface of the floor of the thorax; take the opportunity of examining them, recalling your study of the skeleton.

Notice two muscles attached to the inner anterior end

of the sternum. These are the **sternohyoid** and **sterno-mastoid muscles,** which you will meet with in the neck. They will now have to be cut through.

Now cut transversely along the intercostal space between the 1st and 2nd ribs, and remove the thoracic floor.

Drawing.—Make a drawing to show the internal mammary vein and artery *in situ* in the thoracic floor in its natural position, and indicate the branches of the artery and the tributaries of the vein.

Laboratory Notes.—1. Write a note explaining the associations of the internal mammary artery and vein with the subclavian artery and the superior vena cava respectively.

2. Write a note also on the method of removing the thoracic floor.

Anatomy of the Thorax

You will have noticed that in removing the ventral wall of the thorax, it was necessary to detach it, in the middle line, from a fold of peritoneum along its whole length. On the dorsal wall a similar sheet is to be seen. Thus the thoracic cavity is completely divided into right and left **pleural chambers.** By raising the diaphragm more or less to its natural position, you will observe also a centrally-situated chamber, rather tubular in form, passing from the diaphragm fowards to the heart, where it is continued round that organ. This is the middle one of the three thoracic cavities, and is known as the **mediastinal cavity** or **mediastinum.** In front, it contains the heart in its pericardium and other centrally-situated organs. Behind the heart the mediastinal cavity is almost empty.

In removing the ventral wall of the thorax, the **pleura,** or membrane lining the pleural chambers, has been partially taken away, leaving the cavities open; this is inevitable since the pleura adheres so closely to the wall of the thorax. Thus one lung in each lateral pleural chamber is exposed.

Before displacing any of the thoracic viscera, note the perfect packing of all the organs, each fitting closely against the other with little or no space to spare; the only noticeable empty space is the posterior portion of the mediastinal

chamber. This close fit of all the organs is less noticeable in a specimen which has been preserved for some time, in which much shrinkage has occurred.

Note the conical form of the thoracic cavity. At the anterior end is a pink and highly vascular body (hence the colour) called the **thymus gland**; this organ varies in size according to the age of the animal. In young rabbits it is
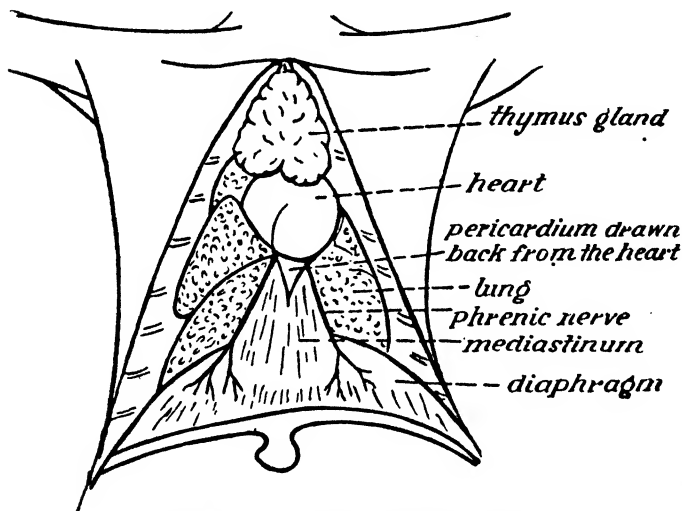
Fig. 46.—The thoracic viscera *in situ*.

large and may even completely cover the ventral surface of the heart. The **heart** is seen to occupy the middle of the thorax, its apex inclined slightly towards the animal's left side. Surrounded by the membranous **pericardium**, the divisions of the heart will not yet be very clearly seen. On each side of the thoracic cavity, almost filling its own pleural chamber is a **lung**, a soft, pinkish organ (remember that it is very vascular), divided into lobes. With your fingers, displace the various lobes of the lungs and see that the right has four lobes while the left has but two. While

feeling the lungs, note their spongy, elastic nature—a
character which, of course, is best demonstrated in a fresh
specimen.

The posterior wall of the thorax is the **diaphragm.** Hold
up the diaphragm vertically, when you will see that it is
convex on the thoracic side. You will also notice that it
has a broad margin of muscle and a more transparent
fibrous portion in the middle, which corresponds more or
less with the area of the end of the mediastinal space.

As the walls of the mediastinal space are stretched, note
that at their right and left limits is a rather delicate nerve
which branches just before it reaches the diaphragm, over
whose surface the branches spread. These are the **phrenic
nerves**; they are the motor nerves of the muscles of the
diaphragm. You will notice that anteriorly, each nerve
emerges from between the lung and the heart—in fact in
the walls of the mediastinal chamber. Originating in the
neck, the phrenic nerves traverse the whole length of the
thorax. On the posterior surface of the diaphragm, in the
middle line, you will see the attachment of the fold of
peritoneum, the falciform ligament, in which the liver is
enveloped.

Drawing.—Make a drawing to show the organs of the thorax
undisturbed.

Laboratory Notes.—Make notes on (1) the divisions of the thorax;
(2) the number of the lobes of the lungs; and (3) the size of the
thymus gland.

As you hold up the diaphragm, you will see the median
attachment of the mediastinal wall to the dorsal wall of
the thorax. [The similar ventral attachment has, of course,
been removed.] In this dorsal median attachment, you
will see the huge posterior vena cava (called also the inferior
vena cava and postcaval vein) coming through the dia-
phragm, and with a slight bend ventralwards (upwards in
the dissection) making straight for the heart.

While the anatomy of the thorax is fresh in your mind,
you will be in a position to understand the mechanism of
respiration. The compactness of the organs in the thorax

in the freshly killed animal, in which the lungs have collapsed, will tell you that on inspiration or in-breathing, room must be found for the expanded lungs without pressure on the heart and main blood vessels. The intercostal muscles cause a movement of the ribs forwards and outwards, and
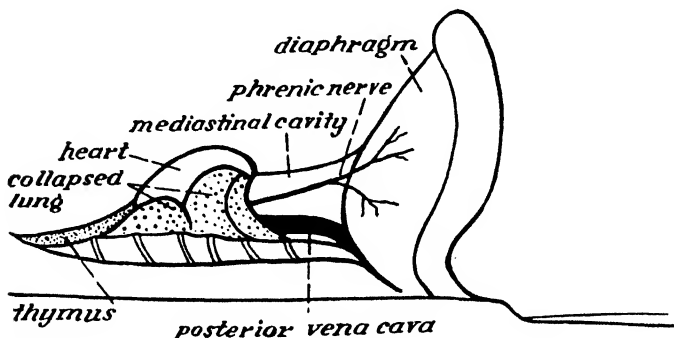
Fig. 47.—Lateral view of the thoracic viscera. Note that the posterior concavity of the collapsed lung would fit the convexity of the diaphragm.

the muscles of the diaphragm contract to flatten or reduce its convexity. Hence the cavity of the thorax is enlarged in all directions. The empty part of the mediastinal cavity can be compressed, and thus, all round, there is room for the great expansion of the lungs by the inrush of air into them. Expiration, or breathing out, is effected by the reduction of the thoracic cavity (1) by the elasticity of the lungs which you have noticed; and (2) by the relaxation of the intercostal and diaphragm muscles.

The Heart and the Principal Blood Vessels of the Thorax

Your object is to expose clearly the heart, the arteries leaving and the veins entering it. But at the same time care must be taken not to destroy nerves which must be studied.

You are advised to turn the animal round so that the head is towards you; this obviates stretching over the whole animal and brings the dissection nearer. It also lessens the confusion of the right and left sides.

First examine Fig. 48. Much of the anatomy shown there is obscured by the thymus gland which must be removed. Before you actually begin to dissect away the thymus gland, examine it carefully to see exactly what it *does* cover, and, consulting Fig. 48, keep the following in mind: The pulmonary arch, the aorta, the anterior (superior) venae cavae, the ductus arteriosus, the phrenic nerve, the vagus nerve (or pneumogastric nerve) and the recurrent laryngeal nerve.

REMOVAL OF THE THYMUS GLAND. Lift the gland forward and clear it by blunt dissection (using the back of a scalpel) from the pulmonary arch and the aortic arch with the ductus arteriosus connecting them. The first large vessel you see, leaving the right ventricle, and bending over to the left, is the **pulmonary arch.** At the side of the heart, the pulmonary arch is crossed by the **left anterior vena cava** coming to the right auricle passing under (dorsal to) the left auricle. At the place where this crossing occurs is the **ductus arteriosus** which joins the pulmonary arch with the **aortic arch.** Probe carefully with the back of a scalpel until you find the aortic arch and the ductus arteriosus. By blunt dissection, push the substance of the thymus gland aside till you can locate the left **vagus nerve** and its branch, the left **recurrent laryngeal nerve,** leaving it to pass round the ductus arteriosus to run forwards alongside the carotid artery. Having located these parts, removal of the gland is only a matter of patient blunt dissection. On the right side the removal of the thymus is relatively easy, if you first locate the vagus nerve and its branch, the right recurrent laryngeal nerve, passing under the subclavian artery.

The vagus nerve will be seen to run along the inner side of the anterior vena cava, and the phrenic nerve along the outer side, on each side.
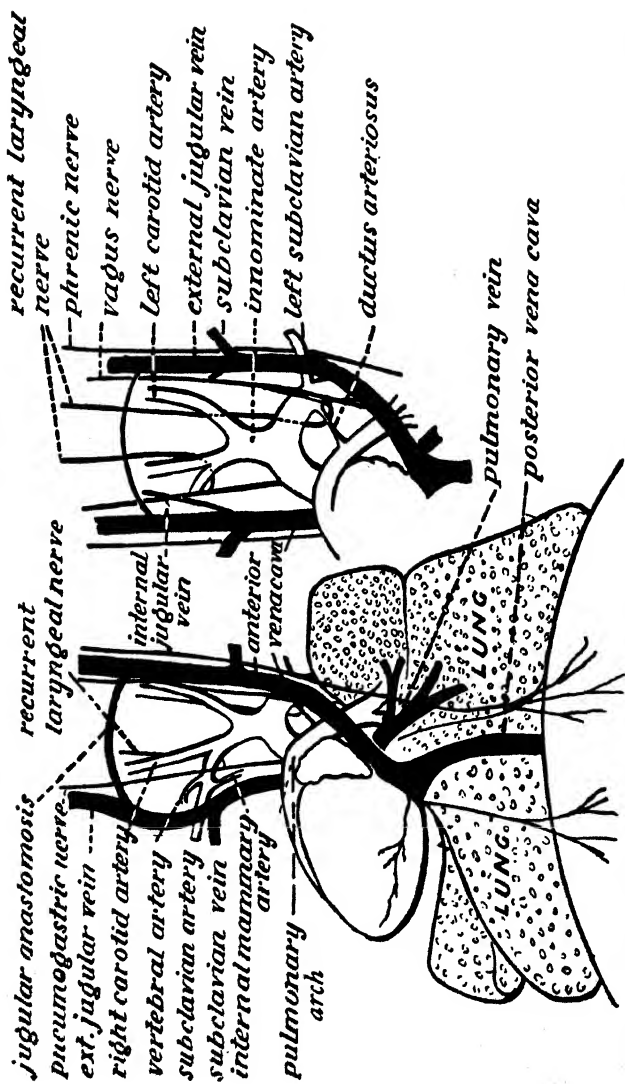
Fig. 48.—The principal blood vessels and nerves near the heart. On the right, the left anterior vena cava has been drawn aside to show the ductus arteriosus. On the left, the right anterior vena cava has been drawn aside to show the vertebral and internal mammary arteries.

Labels (left side, top to bottom):
jugular anastomosis
pneumogastric nerve
ext. jugular vein
right carotid artery
vertebral artery
subclavian artery
subclavian vein
internal mammary artery
pulmonary arch
recurrent laryngeal nerve
internal jugular vein
anterior venacava

Labels (right side, top to bottom):
recurrent laryngeal nerve
phrenic nerve
vagus nerve
left carotid artery
external jugular vein
subclavian vein
innominate artery
left subclavian artery
ductus arteriosus
pulmonary vein
posterior vena cava

LUNG
LUNG

Being now in a position to see the large blood vessels passing beneath (dorsal to) the first rib, you can remove it with safety.

REMOVAL OF THE FIRST RIB. With the end of the scissors, locate the first rib. Then, keeping the blade of the scissors as close as possible to the under side of the rib, cut through it. Repeat on the other side. Then, raising the rib with the forceps, with a sharp scalpel, clean away all attachments to the ribs and manubrium and remove. All that is now required is patient and careful cleaning up.

THE HEART. The heart is invested by the **pericardium,** a very thin, yet relatively tough membrane. In order properly to study the divisions of the heart and the roots of the great vessels, the pericardium must be removed. Here again, great care and infinite patience are required; to puncture a vessel is the easiest thing in the world and in a dissection means disaster. See that the scissors and scalpel are really sharp, for blunt instruments are the cause of much trouble.

Lift the pericardium away from the heart with forceps and make a snick in it with the scissors. Then, keeping the pericardium always raised, cut only so far as it is seen to be free from the underlying heart and blood vessels. Sometimes it is convenient to work with two pairs of fine forceps, gently tearing away the pericardium. Take your time and make quite sure that you cut nothing but pericardium. Especial care will be necessary round the great venae cavae. When all the pericardium is cleared away, the heart and vessels will stand out clearly.

Distinguish the parts of the heart consisting of four chambers—right and left **ventricles** and right and left **auricles.** The ventricles have tough, thick walls, and are generally paler than the thin walled auricles through which the blood shows more easily.

THE PRINCIPAL VESSELS. You have already become acquainted with the posterior vena cava, anterior venae cavae, pulmonary arch and aorta. Trace them to the chamber of the heart with which they are associated. At first sight it appears as if the left anterior vena cava enters the left auricle; this is because connective tissue binds the vena cava to this auricle. Careful clearing of the connective tissue will show that the vena cava passes to the right auricle.

The pulmonary arch leaves the right ventricle and curves over to the left. Turn the heart to the right and trace the vessel under (dorsal to) the anterior vena cava where it will be seen to divide into two—a right and a left—**pulmonary arteries** entering the lobes of the lungs. You will find the pulmonary arch is bound to the left anterior vena cava by connective tissue which must be cleared away in order to show the divisions of the arch to the lungs. (See Fig. 48.)

While in the vicinity of the base of the lungs, look for the **pulmonary veins**; tributaries come from the lobes of the lung and unite to form a short main vessel to enter the left auricle.

Turn the heart over to the left and trace the venae cavae to the right auricle, and note the pulmonary veins coming from the right lung.

Turning the heart back to the right, note the way in which the aorta leaves the left ventricle and curves over to the left and dorsalwards to continue in the mid-dorsal line. The **innominate artery** is a short, stumpy vessel, which, after branching off from the middle of the aortic arch, runs forward and almost immediately gives rise to the two **carotid arteries** by forking. In some cases, the innominate artery is suppressed and the carotid arteries arise directly from the arch. The origins of the **subclavian arteries** to the fore limbs should be carefully noted—the right subclavian artery branching from the right carotid soon after the origin of this vessel, and the left subclavian artery leaving the aortic arch direct where the arch begins its direction posteriorly.

Close to each of the subclavian arteries are the corresponding **subclavian veins** entering the superior venae cavae.

Almost exactly where the subclavian artery passes under (dorsal to) the anterior vena cava on the right side, it gives off the **vertebral artery** forwards and dorsalwards to
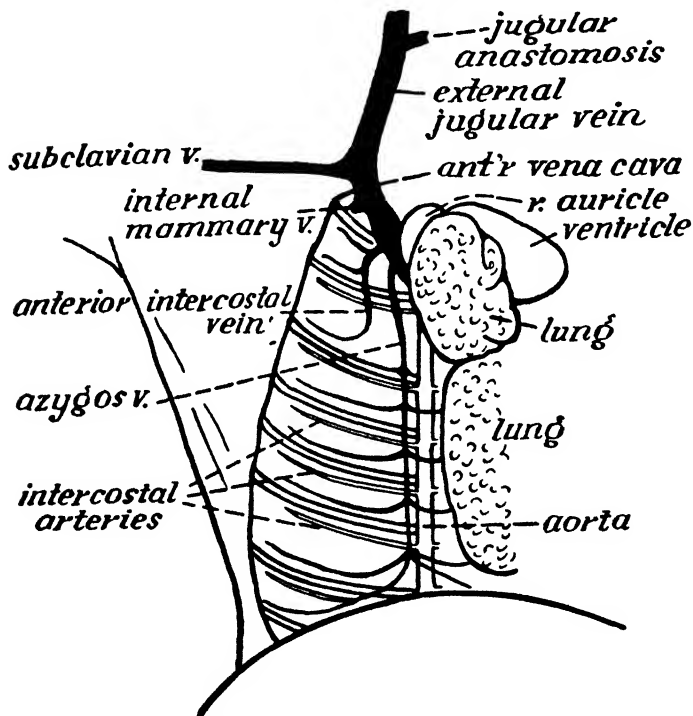
Fig. 49.—The vascular system of the dorsal wall of the thorax.

the vertebral column where it enters the vertebraterial canal to supply the brain and spinal cord. (See Fig. 48.) The left vertebral artery arises from the left subclavian artery at about $\frac{1}{4}$ inch ($\frac{3}{4}$ cm.) from the origin of that vessel, and passes dorsalwards to the vertebral column.

Very near to the origin of the vertebral artery is the **internal mammary artery**, leaving the subclavian artery and running posteriorly. You have already seen the internal mammary artery and vein traversing the inner side of the ventral wall of the thorax (page 120); they had to be severed when removing the ventral wall. You can now see the cut stump of the vein entering the anterior vena cava just after the vena cava has received the subclavian vein.

A little nearer the heart, the right anterior vena cava receives two more veins, (1) the **anterior intercostal vein**, which drains the area of the first four ribs, and (2) the asymmetrical **azygos vein**, which is present only on the right side, and is made up of tributaries from the last five ribs on each side; it joins the right anterior vena cava about ¼ inch before the vena cava enters the right auricle. Alongside these veins are the **intercostal arteries** which join the aorta directly.

Find the aorta passing along the median line of the thorax behind the heart. Note again the intercostal arteries branching off. By drawing the aorta to one side, you will see small white patches in serial order along it; these are the **sympathetic ganglia** of the thorax, connected by fine nerves. This sympathetic chain can be traced backward to show its continuation with the abdominal sympathetic system. To do this, cut through the diaphragm at its outer limit.

Do not omit to notice the **oesophagus** along the dorsal side of the thorax. The nerve which runs along it is the vagus or pneumogastric nerve; make a special note of this nerve, as you will meet with it again later on when dissecting the neck.

Drawings.—Make such drawings as are necessary to illustrate the heart (ventral view) and the complete vascular system of the thoracic region. Do not omit the vertebral, internal mammary, and intercostal arteries; and the anterior intercostal and azygos veins.

REPRODUCTIVE ORGANS

For the dissection of the reproductive organs, it is advisable to use specimens about 3 months old. Younger ones may not show all the details, whereas in older ones

the organs are usually obscured by fat so that dissection is rendered difficult.

If a fresh specimen is used, the gut may be rapidly removed by cutting through the rectum at about one inch (2½ cm.) from the pubes and slitting the mesentery as close to the rectum as possible as far as the region of the kidneys. At this point the gut is attached to the dorsal surface of the abdominal cavity by folds of mesentery which can be cut through without much loss of blood. Break down the connective tissue attachment to the stomach, cut across the oesophagus posterior to the liver, and remove the alimentary canal in one piece.

Dissection of the Male Reproductive Organs

Without further dissection than the removal of the gut and general cleaning up, the structures shown in Fig. 50 will be easily traceable.

With your finger, draw back the bladder so as to show the two ureters entering the bladder. You have brought the dorsal side of the bladder into view and should remember that the ureters enter on the dorsal side. Curling round each ureter just where it enters the bladder you will at once recognise a **vas deferens**. Trace these vasa deferentia back to the testes.

The **testes** will vary in size according to the sexual maturity of the animal; in the young animal they are almost bean-shaped, but in older specimens more like a short sausage. Each is enveloped in a sac-like pouch called a **scrotum** or **scrotal sac**, which is an evagination of the abdominal wall, and the cavity of each sac communicates with the abdominal cavity by the **inguinal canal**. Notice that from the anterior end of the testis is a cord-like structure called the **spermatic cord** attached to the dorsal body wall. It consists of the spermatic artery, vein, and nerve with connective tissue. The cord passes to the testis through the inguinal canal.

Carefully slit the scrotal sac along its whole length so as to expose the testis and much more detail will be revealed.

The spermatic cord will now be seen to be attached at the anterior end of the testis to a body which lies along the concave (inner) side of the testis and which is called the
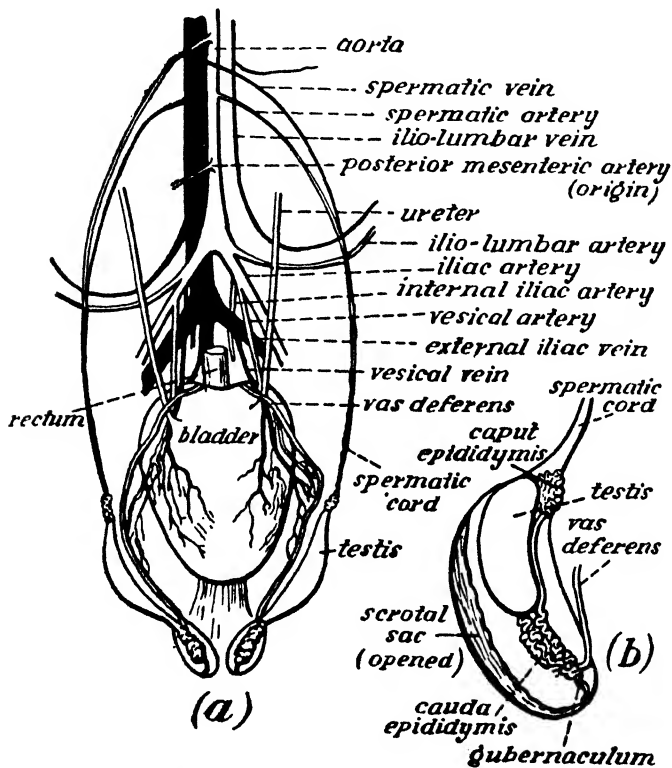
Fig. 50.—The male reproductive organs and their vascular supply.

(a) Ventral view before the division of the pelvic girdle.
(b) The testis dissected out.

epididymis. The epididymis is enlarged at each end; the enlargement at the anterior end is called the **caput epididymis,** while the posterior enlargement is called the **cauda**

epididymis. Close examination with a lens will show that the epididymis is composed of an intricate coiling of tubes which terminate at the cauda epididymis in a tube which is continuous with the vas deferens. The cauda epididymis is seen to be attached to the base of the scrotal sac by an elastic cord known as the **gubernaculum.** Note the vascular supply of the vas deferens from the vesical vessels.
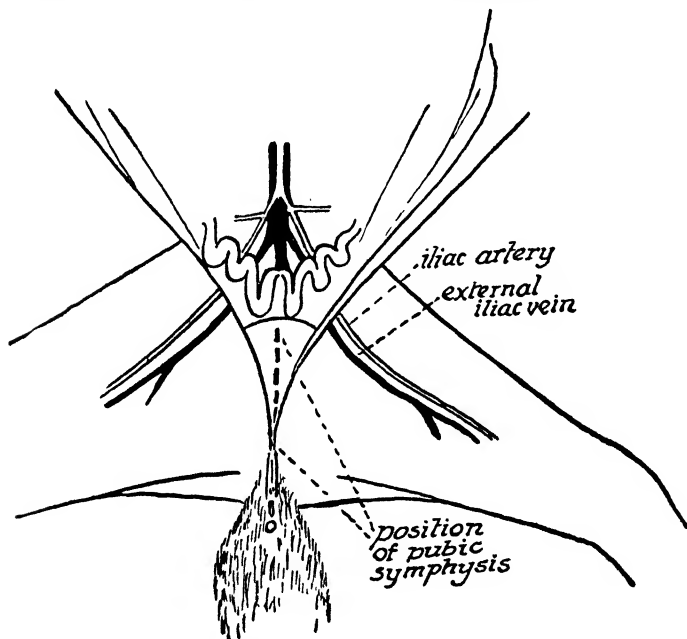
Fig. 51.—Diagram to show where to cut in order to separate the halves of the pelvic girdle.

To complete the dissection, it is necessary to open up the pelvic cavity, separating the pelvic bones (pubic bones) at the pubic symphysis.

First clean off all tissue from the edge of the symphysis till it is visible throughout its length. Then with a strong

scalpel, carefully divide the symphysis, cutting no deeper than sufficient to separate the bones. Then draw the girdle apart and expose the pelvic cavity. Though perhaps more time is required for the dissection, the following alternative method of opening up the pelvic cavity has the advantage of giving more working space: At about ⅛ inch (3 or 4 mm.)
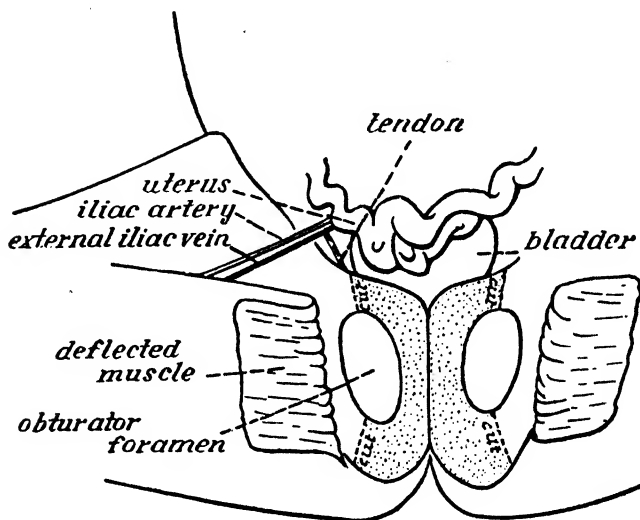
Fig. 52.—Diagram to show where to cut through the pelvic girdle to expose the pelvic cavity. The portion to be removed is shaded.

from, and parallel with, the symphysis, make a bold cut with a sharp scalpel through the muscle down to the bone. Do this on each side of the symphysis. Then with the back of the scalpel, push the severed muscle outwards and expose the bone; this will reveal a soft area which gives to the touch, viz. the obturator foramen which is filled with muscle. Clean the surface of the bone anterior and posterior to the foramen. This done, insert one blade of the bone forceps with the *flat* side *outwards* into the fora-

men, and cut as shown in Fig. 52. In quite young rabbits, strong scissors will suffice. Remove the centre of the girdle.

Laboratory Note.—Make a note of the method you adopt for exposing the pelvic cavity.

Break down all loose connective tissue and expose the **urino-genital canal (urethra)** which is well supplied with blood vessels, and is continuous backwards with the penis. From the root of the penis, you will see on each side a stout cord of tissue running outwards to the girdle—actually to the ischium; these are the **corpora cavernosa.** They relieve the delicate urethra from any undue backward tension of the penis. Note that the covering of the penis is loose to form the sheath known as the **prepuce.**

Your next task is to trace the vas deferens from the testis to its termination. To do this, it will be necessary to free the urethra from the connective tissue attachment to the rectum. Turn the bladder, urethra, and penis so as to get a side view, and very carefully, with the back of a scalpel, break down the connective tissue connections until the rectum is quite free. You can then trace the vas deferens from where it curves round the ureter, and see it with its fellow of the opposite side running along the dorsal wall of the bladder. If you now lose sight of it, it is because it is hidden by the **uterus masculinus,** which is a median sac opening into the urethra and lying closely attached to the dorsal walls of the urethra and bladder. This needs careful separation, when the vas deferens will be seen joining the neck of the uterus masculinus.

Note the glands associated with the reproductive organs; their position on the dorsal side of the urethra will be followed by reference to Fig. 53. They are the **prostate, Cowper's** and the **perineal glands.** On the dorsal surface of the rectum you will see the **rectal gland.** In young animals Cowper's gland will most probably not be discernable; the prostate will be small; but the perineal gland should be easily detected.

The richly vascular condition of the urethra and its

posterior vena cava
aorta
ureter
genital vein and artery
ilio-lumbar vein
ilio-lumbar artery
vesical artery
iliac artery
external iliac vein
vesical vein
internal iliac artery
internal iliac vein
uterus masculinus
vas deferens
inguinal canal with
spermatic cord
caput epididymis
testis
prostate gland
cauda epididymis
Cowper's gland
perineal gland
rectum
urethra

bladder

Fig. 53.—The male reproductive organs in side view.

associated glands is effected by a branch of the internal iliac artery and a tributary of the internal iliac vein.

Drawings.—Make drawings of the male reproductive organs both from a ventral and a side view. Include the vascular supply. Give a detailed drawing of the dissected testis.
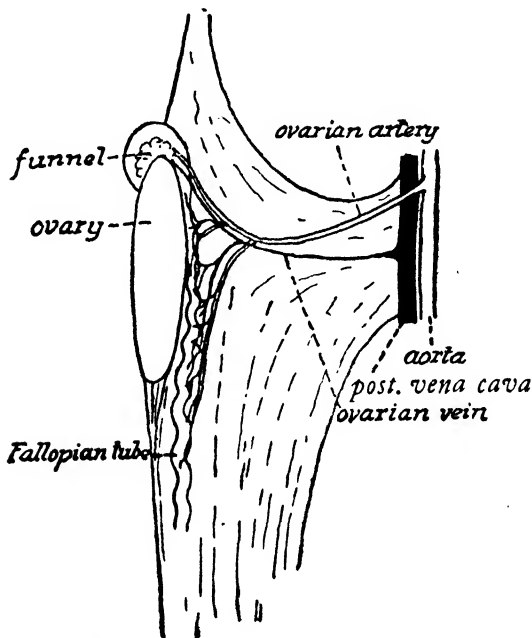
Fig. 54.—The right ovary and its vascular supply in a young rabbit.

Dissection of the Female Reproductive Organs

Assuming that the gut has been removed, the reproductive organs in the female rabbit, as in the male, are found in the posterior part of the body cavity. You will expect to find an **ovary** on each side, from each of which a **Fallopian tube** passes backwards to become continuous with a **uterus**. In the middle line, the two uteri join the median **vagina**.

Without further dissection, all the above may be seen. Drawing back the bladder, first locate the prominent uteri, one on each side. Each uterus is a wide tube with considerable convolutions; its size depends on the maturity of the specimen, and should the animal be pregnant, the form of the uterus will be difficult to recognise, for the developing embryos contained therein will cause great expansion. Follow the uterus of one side outwards and forwards. The tube narrows down to the slender Fallopian tube, whose expanded termination embraces the ovary. The ovary is quite a small, ovoid, pinkish body situated close against the dorsal body wall. If the animal is pregnant, yellow spots, the corpora lutea, will be noticed on the surface of the ovary.
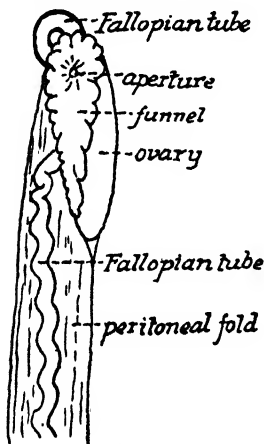
Fig. 55.—Right ovary in a young rabbit turned over to expose the dorsal side.

The wide funnel-like expansion of the Fallopian tube spreads over the ovary on its dorsal side, and in the young female almost covers it. Turn over the ovary and examine this expansion; towards its anterior end you will see an aperture leading to the Fallopian tube, and a seeker may be passed into it.

Hold up the two uteri and note the peritoneal fold by which they are suspended and in which the blood vessels radiate. At the same time, notice that the two uteri lead to the single median vagina.

The vascular supply of the uterus is effected by a tributary and a branch of the vesical vein and artery respectively. (See Fig. 56.) You have already studied the ovarian artery and vein and have noted possible variations. See that your diagram reproduces the conditions found in your own specimen, but examine also your neighbours'
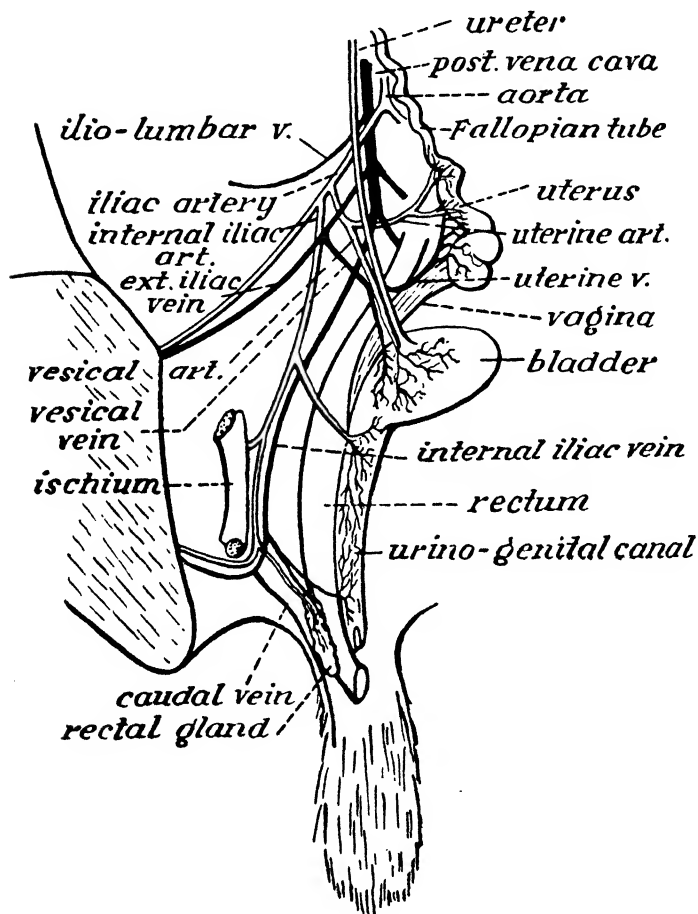
Fig. 56.—The female pelvic cavity after the removal of the pubic portion of the pelvic girdle. The bladder is pulled over to the left.

specimens for possible differences, and make a note of any you find.

The Fallopian tube receives branches from the ovarian artery, and often from the ilio-lumbar artery, and the return blood stream is effected by a tributary to the corresponding vein.

To complete the dissection of the reproductive organs, proceed as instructed in the case of the male (page 133). Expose the symphysis, divide it, and draw the halves apart; or alternatively, remove the pubic portion of the girdle (page 134). The pelvic cavity will then be exposed.

Follow the vagina backwards to where it joins with the neck of the bladder to form the **urino-genital canal** (**urethra**), which terminates with the **vestibule** leading to the exterior by the **vulva**. The vagina is closely bound to the bladder by connective tissue, and can be easily separated by blunt dissection. Note that the urino-genital canal is highly vascular, and receives a small artery from the internal iliac artery; its vein joins the internal iliac
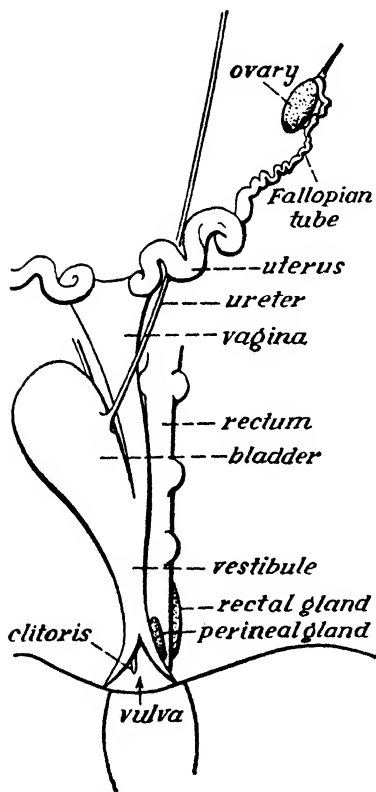
Fig. 57.—Female reproductive organs. The vestibule has been slit open for a short distance.

vein just before this latter vein turns outwards to the back of the leg. On each side of the vestibule near its end is a **perineal gland.** Look also for the **rectal gland** on the dorsal side of the rectum and note its vascular supply. If the **clitoris** is not seen just inside the vulva, ventrally, slit up the vestibule (urino-genital canal) a short distance and find it; it is a thin, cylindrical body which is the counterpart of the penis in the male.

Open up the whole length of the urino-genital canal and the bladder along the ventral side, starting a little to one side of the clitoris. You will then see the openings of the ureters into the bladder and also the opening of the bladder into the urino-genital canal.

Drawings.—Make drawings of the female reproductive organs both from a ventral and a side view. Give also a detailed drawing of the ovary and oviducal funnel. Include the vascular supply.

It is advisable to make a drawing of the vascular system as a whole, and you are now in a position to do this. Do not omit the portal circulation.

DISSECTION OF THE NECK

The dissection of the neck is often regarded as the most difficult dissection in the rabbit. This is on account of the considerable crowding of nerves and blood vessels and the delicacy of some of the nerves. Success lies in disturbing relationships of parts as little as possible; failure may usually be attributed to impatience.

Landmarks

Make a median ventral incision *through the skin only,* along the neck to the lower lip. Deflect the skin or remove it altogether. The exposed surface is covered by muscle and connective tissue through which some of the under-lying structures may be visible. Domesticated rabbits vary somewhat in the strength of the neck muscles; in some, they are robust and little anatomy will be visible through them, while in others the muscles are relatively

thin and transparent. Because it is quite superficial, you will at once identify the **external jugular vein** on each side, formed anteriorly by the union of the **anterior** and **posterior facial veins.** In the middle line is the **trachea** or windpipe; it may be distinguishable, at least in part, by its cartilaginous rings which give it the appearance of a non-collapsible hose pipe.

With great care, cut through the superficial muscular covering in the middle line right along to the lower lip, and turn the flaps aside. This will expose the following parts:—

(1) The **mandibles** covered by the massive **masseter muscles.** On the inner side of the mandible is a glandular mass which is the **submaxillary salivary gland.**

(2) Between the jaws, the **mylohyoid muscle,** like a pad, covering the **hyoid cartilage** supporting the floor of the pharynx.

(3) The **mandibular muscle** (digastric muscle) along the inner edge of each mandible and ending posteriorly in a well-marked tendon.

(4) The two obliquely and backwardly directed **cornua of the hyoid,** from the inner edges of which arise two muscles, one from each cornu; these muscles are the **sternohyoid muscles** and they soon approach each other, meeting in the middle line and covering the whole length of the trachea. You will recall having met with this muscle before, when you saw it attached to the inner side of the anterior end of the sternum (see Fig. 45). Between it and the trachea is another similar muscle, though smaller, called the **sternothyroid** muscle running along the side of the trachea. You should note that between the two posterior cornua of the hyoid is a soft space which is the floor of the **pharynx.**

(5) Near the posterior angle of the jaw, from the end of the cornu of the hyoid is a small muscle running obliquely backwards and downwards (dorsalwards); this is the **stylohyoid muscle.**

submax.
gland

mandible

mand. mus.
tendon

surface
muscle

basihumeralis
muscle

- - mandibular mus.
- - mylohyoid
muscle
- hypoglossal n.
- post. cornua
- - sternohyoid
muscle
- stylohyoid
muscle
- sternomastoid
muscle
- - carotid artery
- - vagus nerve
- - ext. jugular v.
- - inter. jugular v.
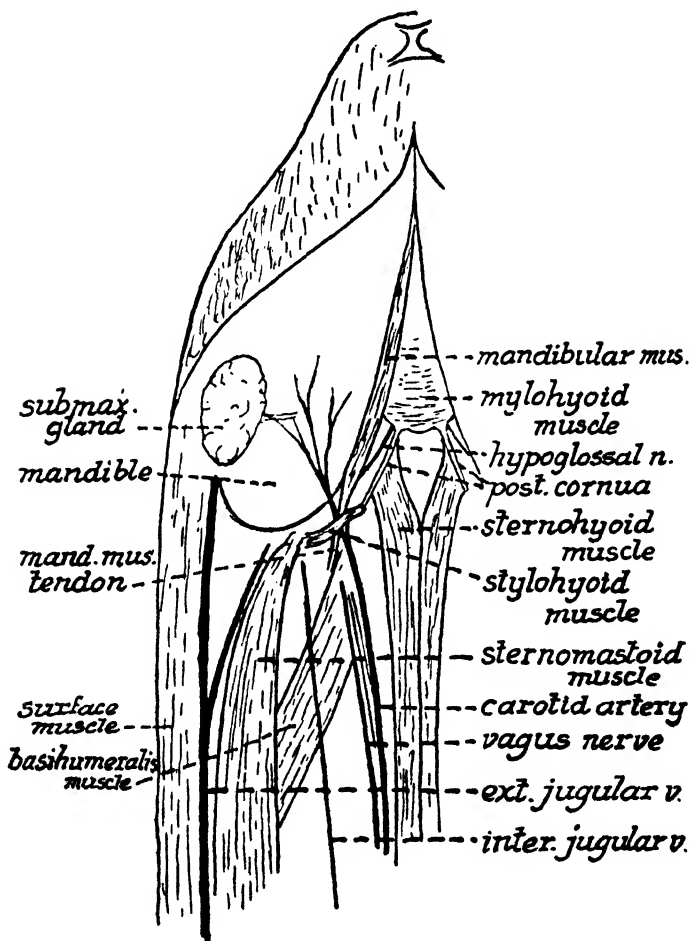
Fig. 58.—The neck after the superficial muscles have been deflected.
The trachea is covered by the sterno-hyoid muscle, and the
submaxillary gland has been turned outwards.

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(6) Under the stylohyoid muscle (*i.e.* dorsal to it) passes the **carotid artery,** which traverses the whole neck and which, at this place, forks into the **external** and **internal carotid arteries;** the former passes to the jaw and face and the latter goes inwards to the brain.

(7) Also under the stylohyoid muscle and passing ventral to the fork of the carotid is the tendon of the mandibular muscle.

(8) A large muscle, the **sternomastoid,** which dips downwards (dorsalwards) with the stylohyoid to become attached to the mastoid process of the skull. This is the second of the two muscles already seen attached to the anterior end of the sternum, before the removal of the floor of the thorax. Between this muscle and the trachea, amongst a great deal of connective tissue giving a bubbly appearance, you will see a number of nerves.

(9) Coming from the brain and passing along with the sternomastoid muscle, is the **internal jugular vein.** When the sternomastoid muscle is pulled to one side, this vein comes away from its original place along the trachea.

The Nerves

So far, you have noted all the important landmarks, and you can now proceed to the dissection of the nerves. Move the sternomastoid muscle outwards and break down the connective tissue between it and the trachea with the back of a scalpel. You will probably find it easier to dissect if you turn the animal round with the head towards you. With the figures turned in the same direction, you should have no difficulty in following all the nerves. It cannot be too often emphasised that success in effecting a good display of the anatomy of the neck depends entirely on patient clearing up of nerve trunks and blood vessels. Take your time. Use a pair of fine forceps and the back of a scalpel, or two pairs of fine forceps to separate things and to remove connective tissue.

There is just one preliminary dissection. Remove the

stylohyoid muscle, cutting it at the end of the cornu of the hyoid and close to the place where it turns inwards. Be sure nothing else is removed.   Then similarly very carefully
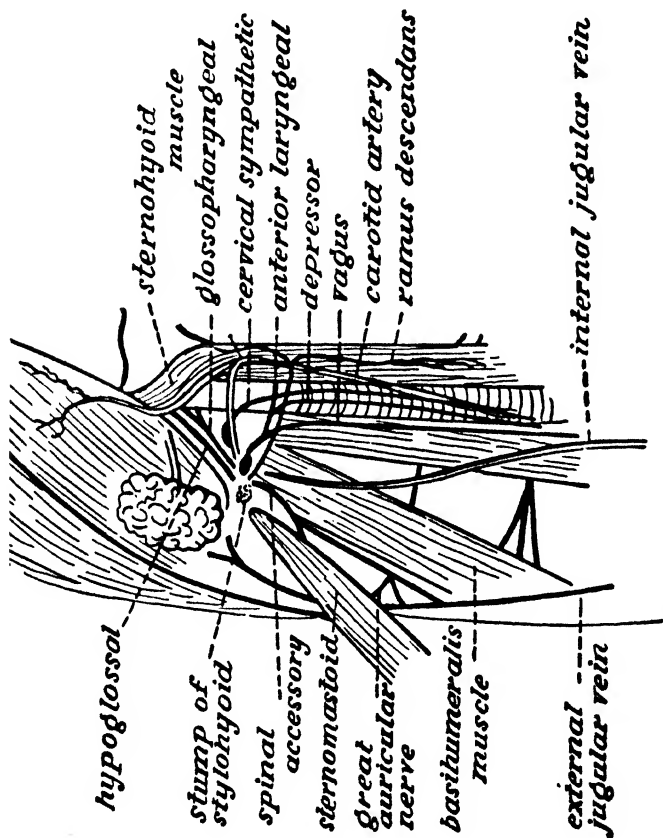
Fig. 59.—The nerve trunks of the neck.

remove the tendon of the mandibular muscle after turning the submaxillary gland over the angle of the jaw.   If you now pin the carotid artery so that it is pulled a little

inwards over the trachea (see Fig. 59), all should be ready for an examination of the nerves.

Alongside the carotid artery you will see longitudinal nerve trunks. The largest of these is the **vagus nerve,** a nerve with which you became acquainted when dissecting the thorax. At its first appearance near the stump of the stylohoid muscle it has a ganglion (the **vagus ganglion**). It then runs along the whole neck alongside the carotid artery, and near the heart, between the carotid and the external jugular vein; it then passes dorsal to the heart along the side of the oesophagus till it reaches the stomach. (See Fig. 48.)

Soon after the ganglion, the vagus gives off a branch passing to the trachea where it turns forwards to spread over the **larynx** at the anterior end of the trachea. This is the **anterior** (or **superior**) **laryngeal nerve.** In order to trace it to the larynx, you must move the sternohyoid muscle, under (dorsal to) which muscle it passes. Its full course is shown in Fig. 60, where the sternohyoid and sternothyroid muscles have been removed from the trachea and the carotid artery drawn outwards.

The **depressor**, or **cardiac depressor, nerve** is a branch of the vagus. It is a very delicate nerve and usually has to be searched for carefully, because it is closely bound by connective tissue to the other longitudinal nerves and the carotid, and dissection really consists of a " combing out " process.

There are thus three longitudinal nerve trunks to be dissected, viz. the vagus, the depressor, and the innermost of the three, the **cervical sympathetic nerve.** The depressor nerve goes to the heart and the cervical sympathetic is **only** the continuation of the sympathetic system you have seen in the thorax and the abdomen. At its anterior end, the cervical sympathetic nerve has a ganglion called **the anterior cervical ganglion;** this will be found to be just beneath (dorsal to) the internal carotid artery. Trace the nerve back to the subclavian artery, and near this vessel you will find another ganglion, the **posterior cervical ganglion** (sometimes called the middle or inferior cervical ganglion).
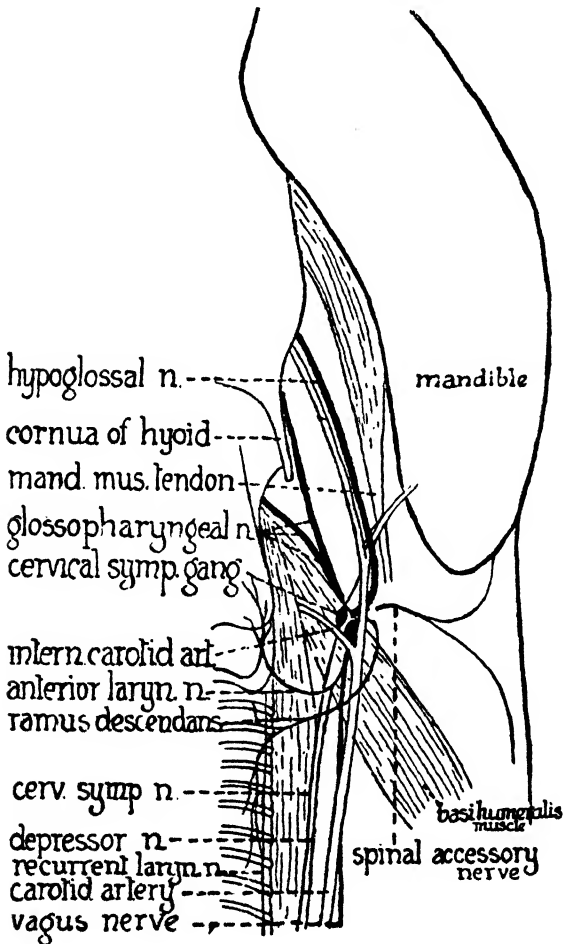
Fig. 60.—A more conventional diagram of the nerve trunks in the neck. Tracheal muscles have been removed.

You will remember that, during the dissection of the thorax, you studied a branch of the vagus nerve which looped round the ductus arteriosus on the left side, and round the subclavian artery on the right. This was the **recurrent laryngeal nerve** which ran forwards close to the side of the trachea and alongside the internal jugular vein. Look for this nerve again and trace it along the side of the trachea.

This completes the dissection of the longitudinal nerve trunks of the neck. You now proceed to deal with the IXth, XIth, and XIIth cranial nerves.

Take first the XIIth cranial nerve, known as the **hypoglossal nerve** because it passes under the tongue. Just inside the posterior inner edge of the mandible, it will be readily visible as a single stout nerve issuing from that centre of nerve radiation near the stump of the stylohyoid muscle. It passes dorsal to the sternohyoid and then under (dorsal to) the hyoid cartilage, its course being parallel to the cornua of the hyoid. It controls the movements of the tongue, being a motor nerve. It corresponds to the first spinal nerve in the frog.

A branch of the hypoglossal nerve is the **ramus descendens.** Sometimes the junction of this branch with the hypoglossal is not immediately obvious, and at first sight it appears as an independent nerve, small, just posterior to the vagus ganglion (Fig. 59). It at first takes a similar course to that of the anterior laryngeal, but passes ventral to (over, in your dissection) the carotid artery and enters the sternohyoid and sternothyroid muscles along the side of the trachea. You will probably notice that it has several connections with spinal nerves (Nos. 1 and 2) among its finer terminations.

In the same vicinity is the **spinal accessory nerve,** the XIth cranial nerve, which leaves the skull with the vagus and passes outwards behind the end of the mandible crossing, ventrally, the tendon of the mandibular muscle. It then divides into two branches, one to the sternomastoid and one to the basihumeralis muscle.

The last of the cranial nerves to be seen here is the

glossopharyngeal nerve, which is the IXth cranial nerve. It is near the hypoglossal nerve and parallel with it, but much deeper down in the dissection. It can be readily recognised alongside a muscle coming from the arm, and it very soon divides into two branches, one passing forwards with the hypoglossal to the tongue as a sensory nerve (taste) and the other branch to the pharynx—hence its name: glossopharyngeal.

Regarding the spinal nerves, the 3rd is interesting as sending a branch, called the **great auricular nerve,** to the ear.

The 4th spinal nerve sends off a branch which is the beginning of the **phrenic nerve** to the diaphragm. Contributions to the phrenic are also received from the 5th and 6th spinal nerves.

The best way to trace the origins of the phrenic nerve is to follow it from behind forwards. It is an important nerve, controlling the movements of the diaphragm. The cessation of the movements of the diaphragm would, of course, cause death.

Note the position of the **oesophagus** in the neck, viz. immediately dorsal to the trachea.

Laboratory Notes and Drawings.—Since the dissection of the neck in the rabbit is so important and often presents difficulties to students, you are advised to make notes, accompanied by sketches to illustrate them, on each stage in the dissection. For example, after the removal of the skin, a sketch of parts shown, with notes on such points as the attachment of the muscles and the presence of structures difficult to show in the figure but which are visible by slight movement of parts. This should be followed by a figure showing the dissection after the removal, or turning aside, of muscles and vessels.

Drawings of restricted parts, such as at the level of the larynx, are most useful, but a comprehensive drawing of the whole of the dissection is essential.

A note on the presence of connective tissue, and the anatomy immediately visible after breaking this down, would be most useful for future reference.

You are advised to draw figures at least as large as natural size, otherwise it will be difficult to insert all structures seen. Correct proportion is absolutely essential.

THE SALIVARY GLANDS

The salivary glands, the secretion of which, known as saliva, plays such an important part during the first stages of digestion, are four in number on each side of the head. They are: (1) the parotid glands; (2) the infraorbital glands; (3) the submaxillary glands; and (4) the sublingual glands.

The **parotid glands** are the largest and are found immediately below the external auditory meatus on each side of the head. No difficulty is experienced in exposing these glands, for the removal of surface tissues is all that is necessary. The gland often extends round the angle of the jaw.
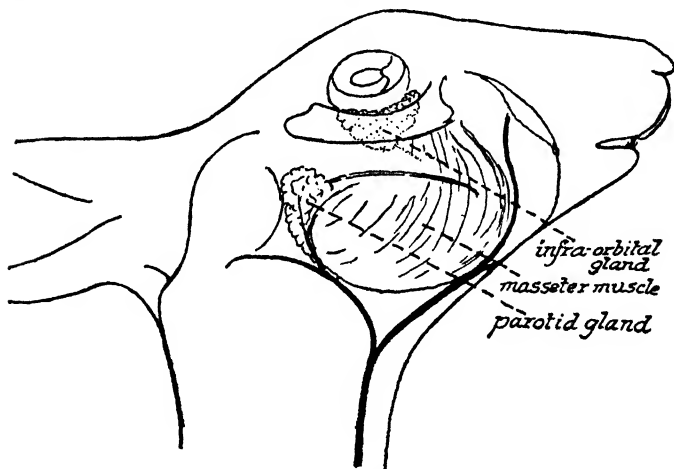
Fig. 61.—Salivary glands in the cheek.

The duct passes forwards round the masseter muscle and enters the mouth in the cheek about half way along the molar teeth.

Similarly the **infraorbital gland** may be exposed. As its name implies, it is found immediately below the eye and

alongside the superior edge of the zygomatic arch. Its duct enters the mouth by passing inwards and not appearing on the surface, close to the opening of the duct of the parotid gland. Both ducts may be traced when the buccal cavity is opened for its dissection.
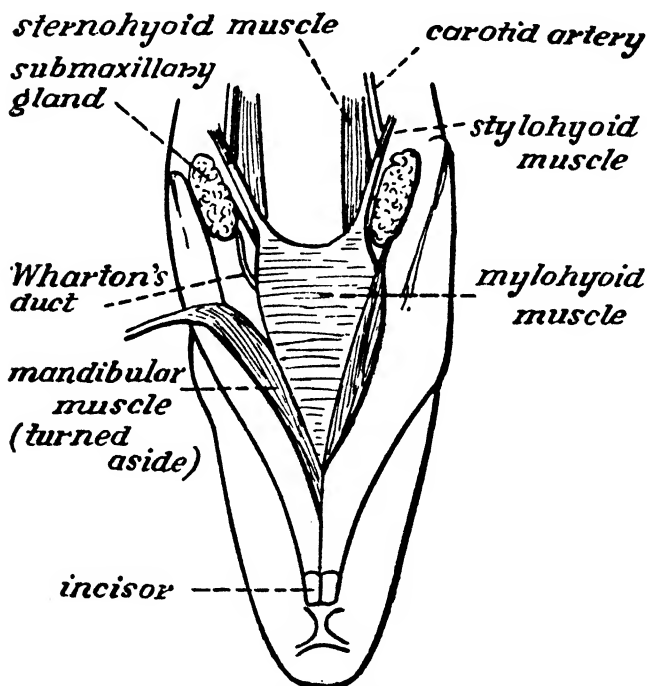
Fig. 62.—Ventral view of the lower jaw with the skin removed and the tendon of the mandibular muscle cut across.

The **submaxillary gland** can scarcely be overlooked during the dissection of the neck. It forms a compact mass at the inner side of the posterior angle of the mandible and level with the posterior cornu of the hyhoid. With the

animal's head directed towards you, as indicated in Figs. 62 and 63, divide the symphysis between the right and left halves of the lower jaw, using a strong scalpel, and separate the two halves. Sever the tendon of the mandibular muscle and move the muscle aside, when the duct of the gland, **Wharton's duct,** will be seen leaving the gland about half way along it; the duct passes transversely and then forwards.
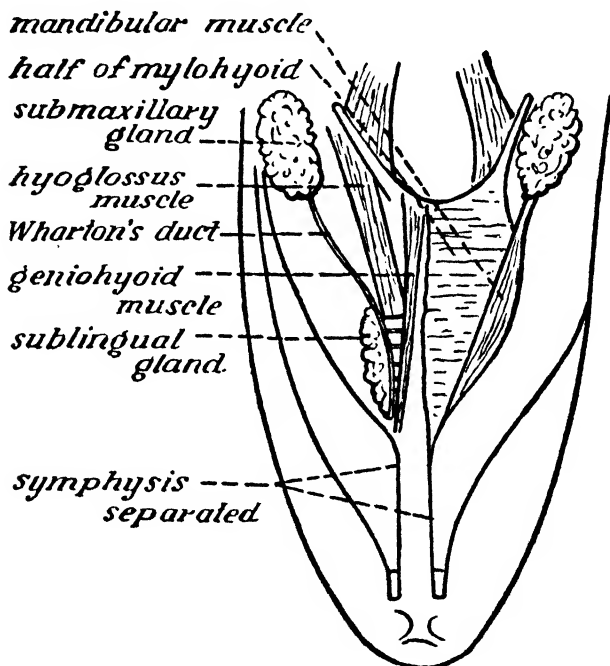
Fig. 63.—Ventral view of the lower jaw with half of the mylohyoid muscle removed.

To trace the duct of the submaxillary gland to its termination and at the same time to expose the **sublingual gland,** cut the mylohyoid muscle along its median line and

deflect one half outwards. On the exposed (dorsal) side of the mylohyoid muscle and attached to it, is the sublingual gland. It extends forwards as far as the mandibular symphysis. Its several ducts will be seen passing from the gland transversely across the ventral surface of the hyoglossus muscle and then beneath (dorsal to) the geniohyoid muscle to open on the floor of the mouth. Wharton's duct can now be followed forward and along the surface of the sublingual gland, to open on the floor of the mouth close to the mandibular symphysis.

Drawings.—Draw figures to show the position of each salivary gland and the courses of the ducts exposed.

Laboratory Notes.—Make notes on the method of exposing the salivary ducts.

DISSECTION OF THE BUCCAL CAVITY AND PHARYNX

From the angle of the mouth, with strong scissors cut back between the jaws and through the masseter muscle at the angle of the jaw, on both sides. The muscle must be completely severed; then pull the lower jaw down, dislocating the jaws, so that the upper and lower jaws are in the same plane. This will completely expose the interior of the mouth. [Note: The sides of the soft palate will be torn in the process of separating the jaws. Imagine the back of the mouth cavity as a somewhat conical space tapering behind. Obviously when the lower jaw is pulled down so far, the sides of this conical space will give way.]

The roof of the mouth forms the **palate,** which is divisble into two parts, the hard and the soft. The **hard palate** is the anterior part and is characterised by a series of transverse ridges; it ends at the level of the hindmost teeth and is followed by the smooth **soft palate.**

Take the opportunity of examining the position of the two pairs of incisor teeth in the upper jaw. Just behind the incisors are the small paired **naso-palatine apertures,** each in a small groove; they form a communication between the **buccal cavity** (that part limited posteriorly by the hard palate) and the nasal cavity.

The **pharynx** follows the buccal cavity. You must reconstruct its form since, as already remarked, its sides have been torn. To see the posterior part of the pharynx it is necessary to look well beyond the base of the tongue. Look for the **tonsils**. They are a pair of depressions with swollen margins.
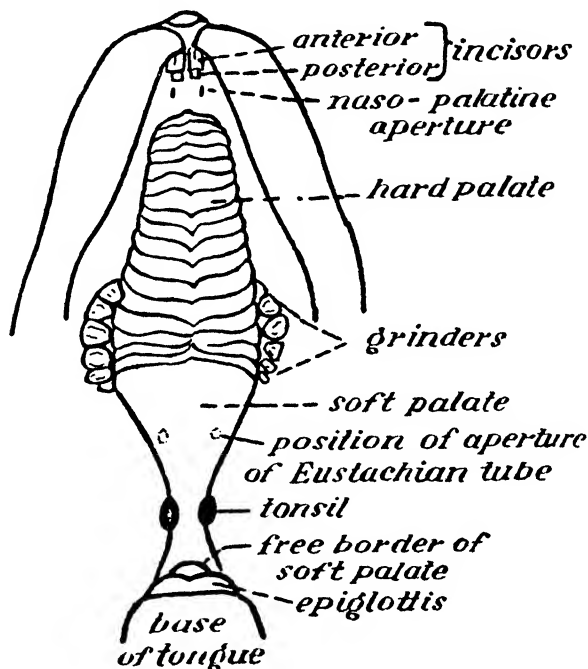
Fig. 64.—Diagram of the roof of the mouth.

Behind the tonsils, the posterior free semi-circular edge of the soft palate will be seen. It forms the aperture known as the **posterior narial aperture** or posterior internal nares, leading to the **narial chamber**. The palate therefore forms a partition between the buccal cavity and pharynx below

and the narial chamber above. The posterior narial aperture forms a communication between the narial chamber and the pharynx.

The **oesophagus** opens into the end of the pharynx; in other words, it is a continuation of the pharynx. The handle of a seeker may be pushed down into the oesophagus and felt under (dorsal to) the trachea.
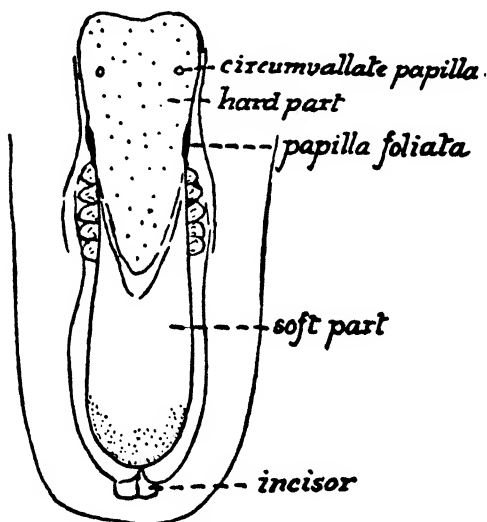
Fig. 65.—Diagram of the tongue.

Just in front of the oesophageal opening and ventral to it is the **glottis**—the opening of the trachea into the pharynx. By pressing the base of the tongue forwards, you will notice the cartilaginous bilobed **epiglottis,** which is on the ventral side of the glottis. Farther back, you will see the projecting margins of the dorsal edge of the glottis, forked in the middle line, and at the sides continuous with the epiglottis. The epiglottis is a flap which can be closed over

the glottis during the act of swallowing in order to prevent food from entering.

With fine scissors, open the posterior part of the nasal chamber by cutting along the middle line of the soft palate from the posterior narial aperture. About half way along the exposed portion of the chamber, at the sides, are the **Eustachian apertures,** orifices leading to the tympanic cavity of the ear on each side. A seeker may be passed through the orifice into the tympanic cavity.

The **tongue** occupies the whole of the floor of the mouth. Note that the surface of the posterior half is hard and roughened compared with the anterior half. Only the front end of the tongue is free, the rest being attached to the floor of the mouth. Minute **taste papillae** may be seen on the surface, particularly at the tip and sides.

A little behind the last tooth on each side of the tongue is a peculiar oval patch with transverse markings; these structures are called the **papillae foliatae.** On the sides of the ridges are aggregations of taste buds. About half way between the papillae foliatae and the base of the tongue, and on its upper surface, are the **circumvallate papillae,** a pair of papillae surrounded by a trench-like depression. On these papillae also taste buds are present.

Drawings.—1. Draw a figure illustrating all parts shown in the roof of the mouth and pharynx, including teeth, naso-palatine apertures, hard and soft palates, posterior narial apertures, tonsils, epiglottis and the position of the Eustachian apertures.

2. Draw a figure of the tongue in position, showing the position of taste areas.

Laboratory Notes.—Make a note of the positions and relationships of the mouth cavity and the nasal passage. Write a note also on the form of the pharynx and the result of dislocating the jaws.

DISSECTION OF THE HEART

The mammalian heart, as illustrated in the rabbit, has four chambers arranged in two pairs, viz. right auricle and right ventricle as one pair, and left auricle and left ventricle as the other pair. The right side deals with deoxygenated blood and the left side with oxygenated blood.

Even by touch, it is clear that both the auricles have much thinner walls than the ventricles, and consequently they are of a darker colour, owing to the comparatively transparent walls. Besides, there is no necessity for thick muscular walls, since there is no great demand for muscular contraction, for they are little more than reservoirs. Each auricle has a thickened margin which projects from it and is called the **auricular appendix.**

The right ventricle is smaller than the left and does not extend to the extreme posterior end of the heart. Again, even by feel, you will notice that of the two ventricles the left is much the more thick walled and muscular.

Before removing the heart, sever each of the large vessels entering and leaving it, leaving a short length of vessel in each case. In the case of a fresh specimen, the vessels should first be ligatured.

Pin down the heart, ventral side up, in a dissecting dish and cover with water. The pins should preferably be through the aorta and the extreme end of the left ventricle.

The Right Ventricle and Auricle

The **right ventricle** may be opened first, by cutting away the greater part of the outer wall with fine scissors. In removing the piece of wall, you will notice that the wall is not at all thick. Inside, you will see coagulated blood. This must be very carefully removed in order not to damage the delicate valve. With fine forceps draw out pieces of the clot, always withdrawing in a backward direction and never sideways; frequent washings will be necessary. If you have been successful, you will see a structure not unlike a side view of a parachute, with " strings " anchored by columns of muscle to the dorsal wall; the " umbrella " portion surrounds the passage between the ventricle and the right auricle. This structure is the **tricuspid valve;** the " strings " are the **chordae tendineae;** and the three muscular " anchors " are the **musculi papillares.** The papillary muscles are not large and are rather widely separated. The tricuspid valve guards the **auriculo-ventricular aperture** between the

ventricle and the auricle, allowing passage of blood only in one direction, viz. from the auricle to the ventricle.

From the anterior end of the right ventricle passes the pulmonary arch. With fine scissors make a cut from the previous incision, forwards along the pulmonary arch. This will expose the three **semilunar valves** which surround the base of the arch. They are delicate pockets, the opening of the pocket facing away from the heart. Their function is to prevent any back-flow of blood from the arch to the ventricle, for if any such back-flow were attempted (*e.g.* in the dilatation of the ventricle), the valves would belly out and their edges would come into contact, effectively checking any passage of blood in that direction.
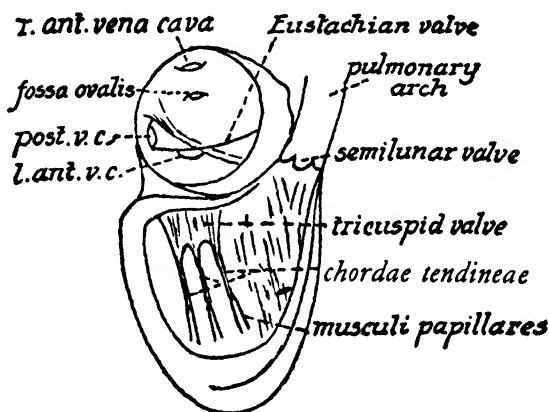
Fig. 66.—The interiors of the right ventricle and right auricle.

The inner walls of the ventricle are thrown into longitudinal muscular ridges which are called **columnae carneae.** Contraction of the muscles will reduce the cavity and force the blood through the pulmonary arch.

Next open the **right auricle,** but in doing so be careful not to encroach near the entrances of the venae cavae.

Make a small opening at first and afterwards extend it, mainly on the left side, next to the pulmonary arch. As before, remove the blood clot, but as there are no delicate internal structures to avoid, there is no danger in the extraction.

You will notice that, thin as was the wall of the right ventricle, that of the auricle is still thinner. However, the inner wall of the auricular appendix is a mesh of thickish muscles called **musculi pectinati.**

With a blunt seeker, probe gently to find the opening of each of the three venae cavae. Anteriorly is the right anterior vena cava; this is easily found. Posteriorly, the left anterior vena cava enters. To find it, first locate a more or less transverse membranous fold called the **Eustachian valve,** a remnant of an embryonic valve; immediately posterior to this is a depression leading to the left anterior vena cava. In passing a seeker into it, direct the instrument towards the left side. The posterior vena cava is found between the other two and a little to the right at the place where the transverse membranous fold begins.

At about the middle of the exposed wall is a depression called the **fossa ovalis,** which represents a former connection between the two auricles.

Pass a seeker towards the right ventricle and through the passage known as the auriculo-ventricular aperture. You will see it emerge under the " umbrella " of the tricuspid valve.

So far, the mechanism is relatively simple. Deoxygenated blood from the venae cavae pours into the right auricle. On the dilatation of the ventricle (**diastole**), blood rushes through the tricuspid valve which is open to blood in that direction; but no blood can be drawn from the pulmonary arch on account of the action of the semilunar valves. However, on contraction of the ventricle (**systole**), the tricuspid valve will close, shutting the aperture to the right auricle; but pressure on the semilunar valves opens them to allow the blood to pass freely along the pulmonary arch to the lungs.

The Left Ventricle and Auricle

Now as regards the left side of the heart, open the **left ventricle** by cutting away only that half of its wall adjacent to the right ventricle. You will immediately notice how very thick is the wall of the left ventricle; considerable muscular power is essential, for the blood must be forced, *via* the aorta, through the whole of the body. In the case of the right ventricle, the passage of blood to the lungs *via* the pulmonary arch and arteries is very short and little resistance is met with; thus the right ventricle does not need such a muscular wall as that of the left ventricle. You will also notice that the columnae carneae are much more strongly developed than in the right ventricle.
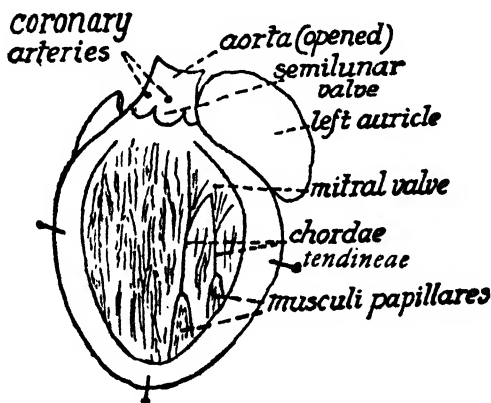
Fig. 67.—The interior of the left ventricle.

The valve guarding the left auriculo-ventricular aperture is a similar valve (the **mitral valve**) to the tricuspid valve; it is, however, only a bicuspid valve in this case. The two musculi papillares are markedly stronger than those of the right ventricle.

Continue the incision along the aortic arch and find a row of semilunar valves similar to those of the pulmonary

arch. Just beyond the valves, you will see the openings of the **coronary arteries** to the substance of the heart.

Now open the **left auricle,** and with a seeker investigate the openings to the pulmonary veins. Sometimes the pulmonary veins open independently in a common depression, but they may unite before entering. Pass a seeker through the auriculo-ventricular aperture into the ventricle. Work out the direction of the flow of blood and the action of the valves.

pulmonary veins

auriculo·ventricular aperture

auricular appendix
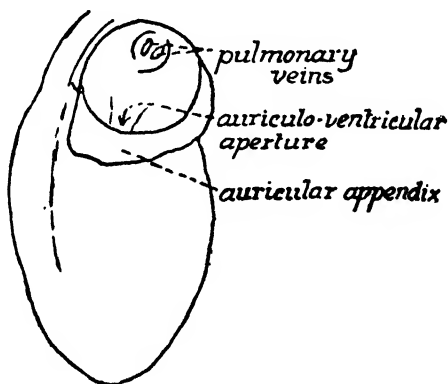
Fig. 68.—The interior of the left auricle.

Drawings.—Several drawings will be necessary, designed to explain as much of the anatomy of the heart as possible.

Laboratory Note.—Write a note on the method of removal of the heart and the method of dissection—under water, which parts of the walls of the heart were removed, extraction of blood clots, etc.

DISSECTION OF THE LARYNX AND TRACHEA

Remove the muscles from the sides of the larynx and trachea, so as to expose every part from the pharynx to the lungs, the heart having already been removed.

Three cartilages support the larynx. On the ventral side and at the anterior end is the **thyroid cartilage,** which is really the first of the series of cartilaginous rings which

support the wind-pipe. It does not extend beyond the lateral sides of the larynx, and is therefore incomplete as a ring.

The second ring, or **cricoid cartilage,** is separated from the thyroid cartilage by the **crico-thyroid ligament.** It is narrow ventrally but dorsally widens considerably, and is a complete ring.

On each side of the thyroid cartilage, you will see a reddish patch, varying very much in size according to the age of the rabbit; it is quite insignificant in young rabbits. This is the **thyroid gland,** and a slender continuation across the ventral side of the larynx connects the two parts of the gland.
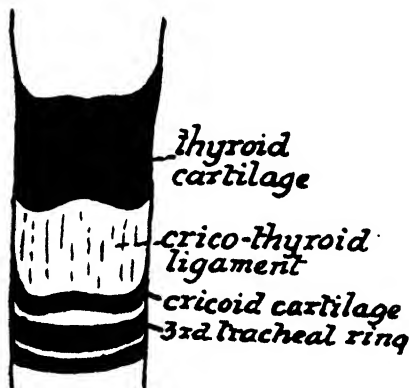
Fig. 69.—Ventral view of the cartilages of the larynx.

Drawing. — Make a drawing of the larynx as seen from the ventral side, labelling the cartilages and the thyroid gland.

Laboratory Note. — Write a note explaining that the thyroid gland varies according to the age of the animal. [You may note that excess of thyroid causes a retarding influence on growth; a deficiency causes obesity.]

It is best to dissect the larynx *in situ.* Make a median ventral incision longitudinally to include a few of the tracheal rings following the larynx, and as far forward as the hyoid. Pin down the cut edges near the cricoid cartilage and examine the interior.

Anteriorly you will have cut beyond the larynx and opened the ventral wall of the pharynx, and you will recognise the posterior narial aperture on a level with the **epiglottis.**

The third of the laryngeal cartilages, the **arytenoid cartilages,** will now be visible in the dorsal wall as a pair of small rounded bodies abutting upon the anterior end of the cricoid cartilage, which you will observe is much broader dorsally. Remember that these laryngeal cartilages are formed from the embryonic visceral arches. Radiating from the arytenoid on each side are the two membranes called the **vocal cords,** the anterior being the so-called false vocal cords and the posterior the true vocal cords. Between them is the area known as the **ventricle.**

The dorsal aspect of the larynx can be examined when the larynx is removed after dissection of the trachea. You can then identify the parts by comparison with the figure given.

Note that you have already seen the anterior laryngeal and recurrent laryngeal branches of the vagus nerve which supply the larynx.

Labels: soft palate; mandible; epiglottis; post. narial aperture; false vocal cord; arytenoid; ventricle; true vocal cord; cricoid

Fig. 70.—The interior of the larynx by a ventral incision.

The **tracheal rings** already exposed internally will be seen to be incomplete dorsally. If you think of it, the incomplete ring is an advantage. Not only does it prevent a collapse of the tracheal tube (which a complete ring would

do), but it will act as a spring when compressed laterally, whereas a complete ring may kink.

Drawing.—Make a drawing of the interior of the larynx to show the position of the cartilages, the vocal cords, and the posterior narial aperture in the pharynx.
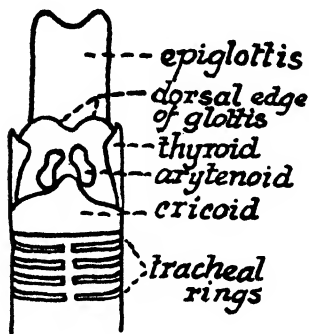
Fig. 71.—The dorsal side of the larynx.

Continue the median incision throughout the length of the trachea to the lungs. Near the lungs the trachea divides into two **bronchi**, one for each lung. The bronchi divide and sub-divide in the substance of the lung.

Drawings.—1. A ventral view of the larynx showing its relative position in the neck, and the position of the thyroid gland. 2. The interior of the larynx. 3. The trachea, partly opened, and its division into bronchi and bronchioles in the lungs.

Laboratory Notes.—Write notes on the relative positions of the gullet and glottis, and the function of the epiglottis. Add a remark on the incomplete nature of the tracheal rings.

DISSECTION OF THE BRAIN

The removal of the brain from a bony skull such as that of the rabbit is usually considered an unsatisfactory business because of the methods generally employed. The cutting away of the bones piece by piece with bone forceps is not only tedious, but usually results in damage to the brain itself, especially those parts, such as portions of the cerebellum, which are completely encased in bone. The operation is, however, not only facilitated, but the removal of the brain almost undamaged rendered possible, by the decalcification of the bones before the operation is attempted.

The Decalcification of the Skull*

If it is proposed to use the head of the specimen upon which the general dissections are carried out for this purpose, then before the specimen is placed in spirit for preservation, the skull must be trephined. This is most readily effected by the use of the special surgical instrument called the trephine. First make a median incision through the skin over the fronto-parietal region of the head, and deflect the flaps of skin so that the frontal and parietal bones are completely exposed. Adjust the central point of the trephine so that it just projects beyond the circular serrated edge, and apply the point to the skull in the median line at about the junction of the frontal and parietal bones. Rotate the instrument backwards and forwards until by the " feel " you judge that the bone has been cut through. Remove the instrument and see that the cut has been made equally all round.

If this has not taken place, then replace the trephine in position, and by deflecting it in the required direction, complete the operation. It is advisable not to allow the serrated edge to go too deeply or injury to the brain will result. Insert the point of a scalpel into the saw-cut, and usually the circular piece of bone can be easily prized out, exposing the upper surface of the cerebral hemispheres. Replace the flaps of skin over the exposed brain to serve as a protection in the preserving tank. [If a number of specimens are being placed in the same tank, it is advisable as a further precaution to place over the exposed brain a pad of cotton-wool soaked in strong spirit.]

When the specimen has been completely dissected, the head may be cut off by severing the neck preferably behind the axis vertebra. The decalcification process is facilitated if as much as possible of the skin and muscle, except over the lower jaw, is removed before placing in the acid. The

* Poulterers and game dealers often decapitate rabbits before sale; in such cases, heads can be obtained either free of charge or at a trifling cost. *Note :* Heads of imported frozen rabbits are unsatisfactory and should not be used.

prepared head should then be placed in a 10 per cent. solution of hydrochloric acid and left for at least three days. [The time required will obviously depend upon the size and age of the skull. For the head of the average small rabbit, such as is recommended for the general dissection, this period is generally ample. An older and bigger skull will want a proportionally longer period.]

The specimen should then be removed from the acid and well washed in water. To harden the brain prior to removal, the head should then be left in strong spirit (or about 15 per cent. formalin) for three days, or longer if desired.

If the head of a fresh specimen is to be used, then it should be trephined in the way described above, cut off from the body and placed in 70 per cent. spirit (or 15 per cent. formalin) for three days before placing in the decalcifying solution.

If a trephine is not available, a portion of the roof of the skull can be removed in a youngish rabbit—it is more difficult in a full grown specimen—by inserting the point of a scalpel into the suture between the frontal and parietal bones and prizing the bones apart. These can then be lifted up and portions cut off from them until a sufficiently large aperture has been produced to permit the preservative to penetrate into the cranial cavity.

The Removal of the Brain

Remove any skin and muscle that may still be attached to the skull, not omitting that on the occipital region, so that the whole of the upper surface and down to the occiput is completely exposed. In many cases the position of certain parts of the brain can be distinguished through the now semi-transparent bone. The upper surface of the cerebral hemispheres will protrude through the circular hole made in trephining the skull, and their forward continuations will be visible. Anteriorly, between the eyes, and posterior to the nasal bones, the olfactory lobes show as two light oval patches.

Holding the skull with the snout turned away from you, put one blade of the scissors (holding the blades horizontal, that is, parallel to the bone) into the circular hole and cut through the skull wall forwards along the edge of the orbit and the outer side of the nasal bone on both sides (see Fig. 72). Remove the portion between the incisions, cutting through any attachments on the under side. This will
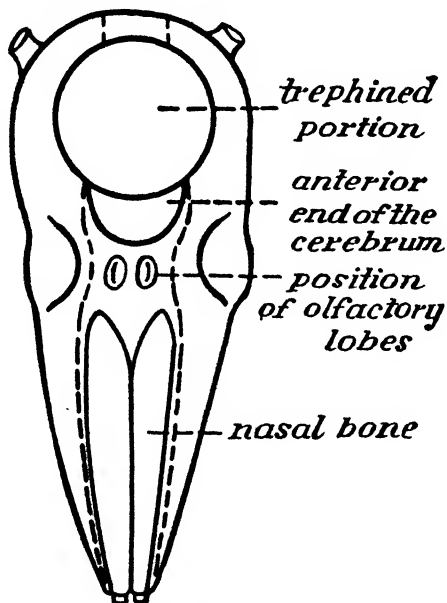
Fig. 72.—Diagram to show the lines of incision in the skull for the removal of the brain.

expose the anterior part of the brain and snout so that the olfactory lobes and the upper edge of the mesethmoid will be seen.

Next reverse the position of the head and cut down to the occiput from the circular hole, on each side, keeping the incisions nearer to the median line than in the previous

operation. This avoids injury to the lateral lobes of the cerebellum. In the removal of the bone between these incisions care must be taken to avoid damaging the cerebellum, which is closely adherent to the roof of the skull. This operation exposes the posterior part of the cerebral hemispheres, the median lobe of the cerebellum and the medulla oblongata. Note the posterior limits of the cerebellum, which can be determined by applying slight pressure with the back of a scalpel. The outline of the IVth ventricle will then be clearly seen behind the cerebellum.

Having first made out its position in relation to the median and lateral lobes, expose the floccular part of the cerebellum by cutting through the bone around it. First cut downwards in front of the external auditory meatus, looking beneath the bone before cutting in order to direct the blades of the scissors correctly, and follow the outline of the posterior border of the cerebral hemispheres. Next cut inwards with a scalpel along the side of the medulla, and as the bone is deflected you will see the flocculus closely surrounded by bone. When the incision has been carried forward sufficiently, *i.e.* to the under side of the flocculus, the bone can be turned aside and the flocculus will come away from within the bone, which can then be cut away completely.

Now the entire dorsal surface of the brain will have been exposed and its removal from the cranial cavity may be proceeded with. Hold the head so that the dorsal surface is downwards, and, starting from the hinder end, free the medulla and allow it to fall forwards. You will then be able to see the under side of the cerebellar region (pons Varolii) which may be freed from any attachments, the weight of the brain pulling it away from the base of the skull. Continue the freeing process forwards, but as you approach the olfactory region, loosen the attachment of the olfactory lobes anteriorly and hold the head closer down in the dish so that when the olfactory lobes are completely freed—which may take place rather suddenly—the brain will not be damaged by falling into the dish.

When the brain has been completely removed, carefully peel off any remains of investing membranes and place it in a small dish of strong spirit.

The Examination of the Brain

If the method given above has been carried through successfully, it should provide you with a practically complete specimen of the brain, yet it sometimes happens that, from the completeness or otherwise of preservation and hardening, some specimens will not show all the essential points with the same degree of clarity. You may find it advisable, therefore, to examine other specimens—those of your neighbouring students—for some of the points of detail.

(1) THE DORSAL SURFACE. Looking at the brain from the dorsal aspect, the most obvious and striking region is the **cerebral hemispheres,** the characteristically largest developed portion of the mammalian brain, occupying about two-thirds of the anterior region. The two hemispheres are roughly pear-shaped and each is applied to the other in the median line, the line of juxtaposition being marked by the **median fissure.** For the most part, the surface of the cerebral hemispheres will appear smooth with no evident furrows (**sulci** or **fissures**), but in the majority of cases (depending to a large extent upon how far the hardening process has gone) a shallow depression, the **Sylvian fissure** can be seen commencing at a point about half-way along the outer edge of the cerebral hemispheres and tracing an oblique course backwards. This fissure divides each cerebral hemisphere into an anterior **frontal lobe** and a lateral **temporal lobe.** Projecting in front of the cerebral hemispheres are the two **olfactory lobes** (sometimes called the **olfactory bulbs**), which appear to emerge from under the front end of the hemispheres.

The hinder part of the brain is occupied by the **cerebellum,** the five parts of which are easily distinguishable. The central portion, roughly rectangular in shape with rounded corners, is the **vermis.** On each side of the vermis is a

median fissure

olfactory lobe

frontal lobe

corpora quadrigemina

cerebral hemisphere

temporal lobe

vermis

pineal body

lateral lobe

flocculus

cerebellum

medulla oblongata
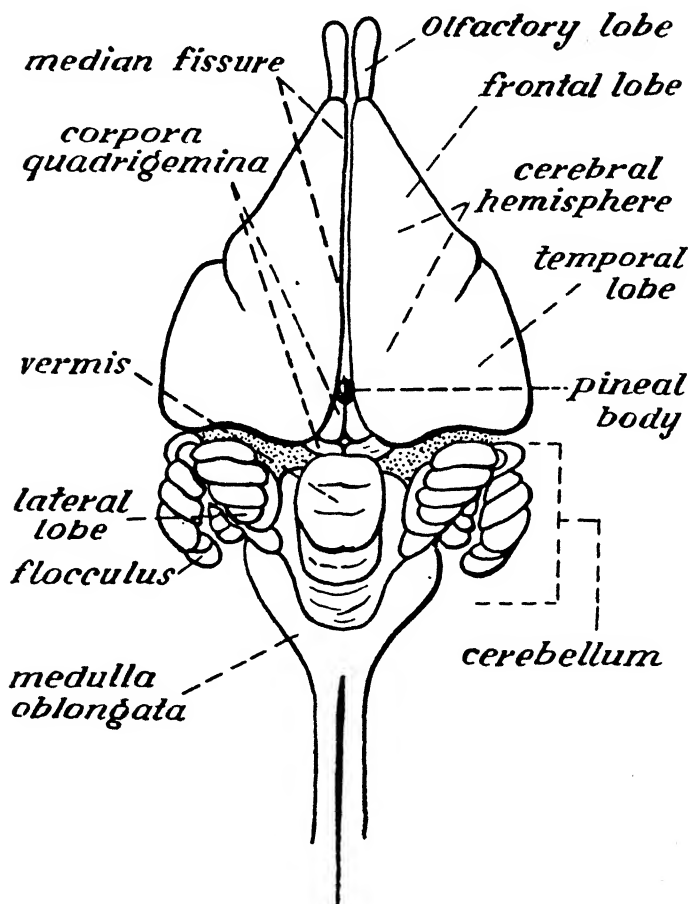
Fig. 73.—Dorsal surface of the brain.

lateral lobe and depending from each lateral lobe, a smaller lobe called the **flocculus**. Note that on the surface of the cerebellum are numerous grooves or sulci marking the foldings of the surface. They are clearly visible with a lens if not obvious to the naked eye. Projecting backwardly from beneath the cerebellum will be seen the hinder part of the **medulla oblongata.**

The foregoing structures are those which are most obvious in a surface view, but which include only the dorsal part of a portion of the fore brain (prosencephalon) and the hind brain. The remainder of the features of the dorsal surface are hidden beneath the backwardly projecting portions of the cerebral hemispheres. The curved outline of these backwardly projecting portions permit, however, some further structures to be seen without involving dissection. With the fingers, gently press the cerebral hemispheres apart, and at the same time press the vermis backwards. Under the lens, four structures, the **corpora quadrigemina** or the **optic lobes** (mid-brain) will then come into view looking rather like a hot-cross bun in which the cross has been displaced backwards. The **thalamencephalon,** which lies still farther forward in front of the corpora quadrigemina, cannot yet be seen, and the examination of this part of the dorsal surface must be postponed until later, but lying between the rounded posterior margins of the cerebral hemispheres, and above the corpora quadrigemina, a darkish body, the **pineal body** can be seen.

Drawing.—Make a drawing of the dorsal surface to include those parts you have seen so far.

Laboratory Note.—Make a note on the covering up of the thalamencephalon and the mid-brain by the backwardly projecting portions of the cerebral hemispheres; also upon the large size of the cerebral hemispheres and cerebellum.

(2) THE VENTRAL SURFACE. Having familiarised yourself with the main features of the dorsal surface of the brain, turn the specimen over and examine the **ventral surface.** You can identify at once the **olfactory lobes,** and note the way in which they merge into the under side of

the **cerebral hemispheres.** The prominent ventro-lateral portions of the cerebral hemispheres approach one another
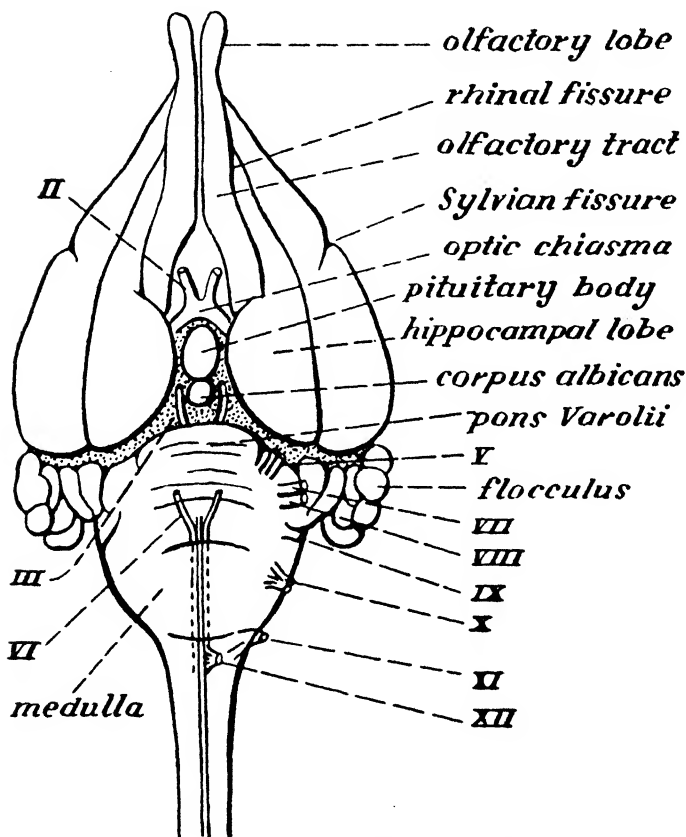
Fig. 74.—Ventral surface of the brain.

until they nearly meet in the middle line, but are separated sufficiently to allow the under side of the **thalamence-phalon** and its associated structures to be seen. Behind

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the cerebral hemispheres will be seen the prominently convex **medulla oblongata,** on each side of which will be visible the under side of the flocculus of the **cerebellum.** Having got your landmarks, now examine the regions in more detail.

The **olfactory lobes,** as they pass backwards to merge into the cerebral hemispheres, are continuous with two medianly situated regions, the **olfactory tracts,** clearly demarcated by fissures (the **rhinal fissures**). The prominently convex portions of the cerebral hemispheres on the axial sides of the backwardly continued portions of the fissures are known as the **hippocampal lobes.** In the middle line, in front of the hippocampal lobes, the cut **optic** (IInd cranial) **nerves** are seen. By using the lens you will see that these two nerves join to form the **optic chiasma** before passing into the brain. Posterior to the optic chiasma is a prominent oval mass, the **pituitary body,** attached to the under side of the thalamencephalon. Posterior to the pituitary body, a less prominent rounded elevation (the **corpus albicans** or **corpus mammillare**) will be seen. On each side of the corpus albicans are the roots of the **IIIrd (oculo-motor) nerves.** On the ventral side of the medulla oblongata, the medianly placed fissure, a forward continuation of the ventral fissure of the spinal cord, becomes less distinct at the anterior end. This anterior, prominently rounded portion is traversed by a transverse band of fibres—the **pons Varolii,** which connects the two halves of the cerebellum. On each side of the median fissure, and arising just behind the pons Varolii, the roots of the **VIth (abducens) cranial nerves** can generally be seen. From the ventro-lateral surface of the medulla oblongata, nerves **V.** and **VII.-XII.** arise, but the distinctness of their roots varies in different specimens. Reference to Fig. 74 will give you the positions of their roots, and if they are not distinct in your specimen, mark their positions in your drawing and make a note to the effect that they were not visible in the specimen.

Drawing.—Draw the ventral surface of the brain, putting in all the points you have seen.

(3) THE DISSECTION. Returning to the dorsal surface, a little dissection will enable you to make out many further points which hitherto have not been visible. First, by placing the middle finger of each hand on the cerebral hemispheres, gently press them apart so that you can see down between them. At the bottom of the median fissure, a band of transversely running fibres, the **corpus callosum**, connecting the two hemispheres will be seen. Also, arising from the hinder part of the thalamencephalon, which lies in front of the corpora quadrigemina, notice a slender stalk, the **pineal stalk**, which terminates in the pineal body already observed. In the left hand, using a duster if preferred, take the brain, which must have been well hardened. In the right hand take a small scalpel, and holding it with the blade horizontal, place the middle finger on the under side so that not more than about one-quarter of an inch of the blade projects beyond the tip of the finger. This is to prevent the scalpel penetrating too deeply into the brain. Push the point of the scalpel with the cutting edge directed towards you, into the side of the right cerebral hemisphere just behind the olfactory lobe until the tip of the middle finger touches the side of the brain. Then, using the tip of the finger as a guide by keeping it in contact with the lateral margin of the hemisphere, make a lateral incision, maintaining the blade horizontal all the time, following the outline of the hemisphere, and continuing the incision around the posterior margin of the hemisphere to the middle line. Lift up the upper edge of the incision and turn it over to your left. You will then see that in the posterior part of the hemisphere the lateral wall has been cut through and that the scalpel has entered a cavity, the **lateral ventricle**, but that anteriorly the hemisphere appears solid.

Lift up the edge of the incision so that you can see where you are cutting, continue the horizontal cut to the middle line, avoiding damaging the prominent rounded mass in the floor of the ventricle and also the anterior optic lobes. Lift off the roof of the ventricle, and note the flattened band of fibres, the **corpus callosum**, on the under side.

olfactory lobe

corpus striatum

corpus callosum

hippocampus major

III rd. ventricle

optic thalamus

lateral ventricle

pineal stalk

thalamencephalon

corpora quadrigemina

valve of Vieussens

IV th ventricle

medulla oblongata
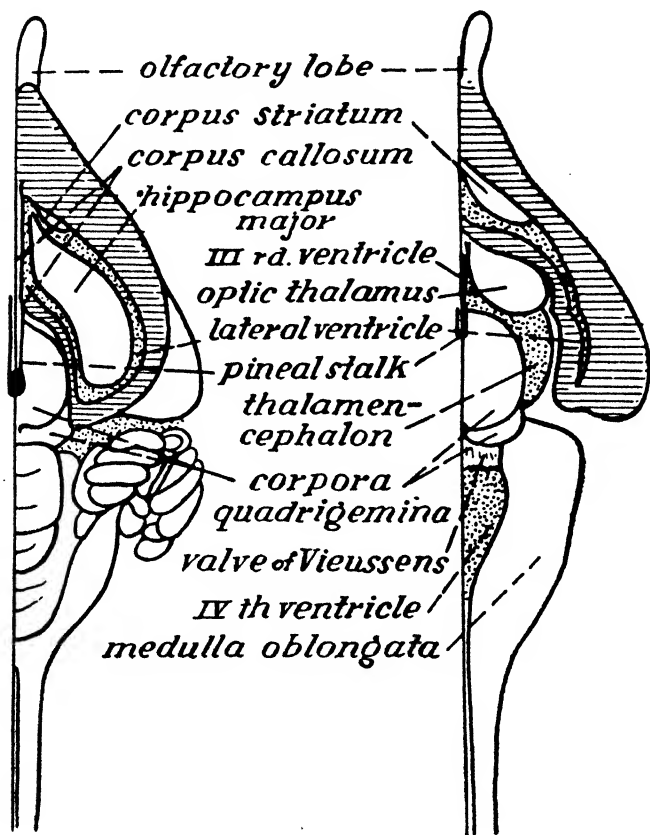
FIRST DISSECTION   SECOND DISSECTION

Fig. 75.—Diagrams to illustrate the dissection of the brain.

[If the point of the scalpel has been inserted too near the dorsal surface, the lateral ventricle will not be entered by the point, and in lifting up the edge of the cut, the roof of the cerebral hemisphere will break away exposing the corpus callosum in whole or in part. If this happens, it is best to continue the removal of the roof with the edge of the scalpel to the mid-line exposing the corpus callosum fully. Then with a pair of fine scissors, divide the corpus callosum where it joins the lateral wall of the hemisphere, and remove it completely to the middle line.]

The removal of the roof of the hemisphere will have exposed the lateral ventricle as you have seen, and the **hippocampus major,** an ovoid rounded thickening of the floor of the hemisphere. With the back of the scalpel press the lateral wall aside and note the extent of the ventricle and that the hippocampus major is continued forwards into a septum lying beneath the cut edge of the anterior part of the corpus callosum and which separates the ventricle from its neighbour. Pressing the anterior part of the wall still farther outwards, another rounded thickening (the **corpus striatum**) in the ventro-lateral wall of the ventricle lying in front of and to one side of the hippocampus can be distinguished.

Drawing.—Make a sketch of the dissection at this point, showing all the features which have been seen so far.

Take a pair of fine scissors, and insert the point of the lower blade underneath the backwardly projecting portion of the cerebral hemisphere so that it lies in the space between the hemisphere and the corpora quadrigemina. Cut vertically through the hemisphere on the outside of the hippocampus and continue the incision forwards in a curve towards the median line following the outer edge of the hippocampus, removing the *floor* of the ventricle only, and exposing the thalamencephalon. Using the left hand, press the remains of the right hemisphere away with the fingers and the left hemisphere with the thumb and examine the area thus exposed with a lens. Immediately in front of the **corpora quadrigemina** is a

thickening, the **optic thalamus**, and in the middle line the root of the **pineal stalk**. Immediately in front of the pineal stalk is the thin roof of the **IIIrd ventricle** which is pushed into the cavity of the ventricle to form a **choroid plexus**. This can be lifted out with the point of a scalpel, exposing more clearly the medianly placed aperture leading into the ventricle.

To display the IVth ventricle, put the point of the scalpel underneath the posterior edge of the vermis of the cerebellum and lift it up, when it usually breaks off. This enables you to see the cavity of the ventricle. With the fine scissors cut along each side of the remains of the anterior part of the vermis and remove it, noting as you do so, in order to leave it behind undamaged, the thin membranous **valve** of **Vieussens**, attached anteriorly to the posterior margin of the corpora quadrigemina. Lifting this up on the point of the scalpel, or with fine forceps, and at the same time depressing the medulla oblongata, you can look into the channel (the **iter**) by which the IIIrd and IVth ventricles communicate, and in the floor of which the **crura cerebri** lie.

Drawing.—Draw the finished dissection, naming all the parts you have shown.

(4) A MEDIAN VERTICAL SECTION. The examination of the brain would not be complete without reference to a median vertical (sagittal) section. Using the specimen which you have been dissecting, take a large scalpel, and placing it edge downwards against the left hemisphere in the position of the median fissure, slice downwards through the brain and continue the cut backwards still keeping to the median line and dividing the corpora quadrigemina, cerebellum and medulla oblongata.

You must not expect that this section will have the exact appearance of the ideal sagittal section figured in most textbooks, but with a little patience most of the features in such a section can be made out. Apart from any imperfections which may have resulted from the sectioning process, it will be found that as a rule the

cerebral hemisphere

corpus callosum

lateral ventricle

fornix

IIIrd ventricle

pineal stalk

corpora quadrigemina

cerebellum

valve of Vieussens

IVth ventricle

crura cerebri

pons Varolii

middle commissure

corpus albicans

pituitary body

optic chiasma

anterior commissure

olfactory lobe

II
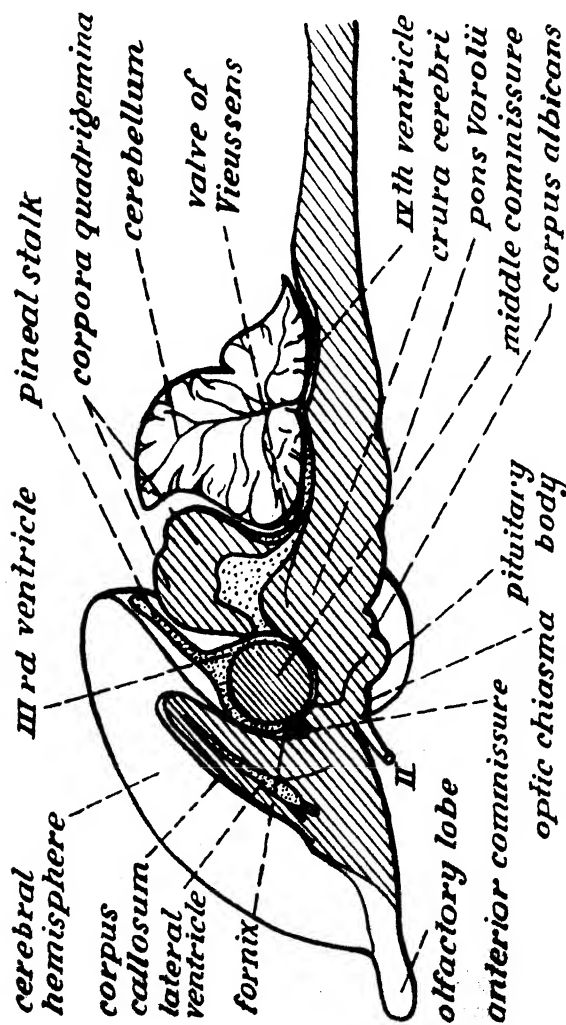
Fig. 76.—Median vertical section of the brain.

cavities of the brain are not as obvious as the figure of an ideal section would lead you to suppose. Examining the cut surface, the general regions of the brain will be evident at once. It is best to do this with the specimen covered with fluid and to use a lens. Commencing from the anterior end, the **olfactory lobes** will be followed by the **cerebral hemispheres,** the backward extension of which, covering the **thalamencephalon** and **corpora quadrigemina** can be fully appreciated. Then, behind the corpora quadrigemina is the large **cerebellum** lying above the **medulla oblongata.**

Now examine the regions in detail. The upper part of the cerebral hemisphere—where the scalpel was placed in the median fissure—has not been cut, and this portion is, naturally, quite different in appearance. At the extreme upper margin of the *cut* portion will be seen what appears to be a thick, whitish line running almost parallel with the outline of the upper edge of the hemisphere. This is the cut edge of the **corpus callosum,** and if the cerebral hemisphere above this is gently pressed aside, a slit will make itself apparent. This is, of course, the connecting channel between the two **lateral ventricles.** The posterior margin of the corpus callosum is rounded and the white line curves around the end of the slit to pass downwards to the front of the thalamencephalon, where it passes into a slight thickening, the **body of the fornix.** Immediately below the fornix, a small, oval body cut across, and apparently embedded in the tissue of this region can usually be made out. This is the cut surface of the **anterior commissure.** With one finger on the mid-brain, and another on the cerebral hemisphere, gently press the cerebral hemisphere to one side, when between the posterior margin of the hemisphere and the large mass in the thalamencephalon, will be seen an aperture into which a seeker can be passed. This is the **foramen of Munro,** the aperture by which the lateral ventricle communicates with the IIIrd ventricle.

The thalamencephalon will almost certainly have been damaged to some extent by the sectioning process, but most of the details will be distinguishable. The most obvious thing will be the big rounded structure seen in

section. This is the **middle commissure,** sometimes called the **massa intermedia,** which traverses the ventricle from side to side and almost completely fills its cavity. Above the middle commissure will be seen the remains of the thin roof of the IIIrd ventricle, forming the **choroid plexus,** distinguishable by being different in colour, and, arising from the hinder part of the roof, the **stalk** of the **pineal body.** Rarely does the section pass along the whole length of the stalk as in an ideal section, but sufficient of the stalk will remain for you to see its position. You will also see that there is only a very narrow cavity distinguishable between the upper surface of the anterior commissure and the roof of the ventricle. Theoretically the cavity of the IIIrd ventricle is continued downwards into the **infundibulum** of the **pituitary body,** the position of which, lying posterior to the **optic chiasma** can be made out. That the cavity does exist can be shown by gently pressing the parts aside when a crack will appear following the line of the cavity. Posterior to the pituitary body, another rounded elevation, the **corpus albicans** or **corpus mammillare** will be seen in section.

The two elevations on the dorsal side of the mid-brain, the **anterior** and **posterior lobes of the corpora quadrigemina** will be easily distinguished, and also the very marked thickening, the **crura cerebri,** which form the ventral part of this region. The cavity of the mid-brain, the **iter** (or more fully, the *iter a tertio ad quartum ventriculum*) or **aqueduct** of **Sylvius,** is not always easy to make out. Generally, however, a slight depression in the cut surface below the corpora quadrigemina can be seen which marks the position of the iter.

Passing to the hind-brain, the apparently solid **cerebellum** will be seen occupying the greater part of the dorsal surface and, in front, partly overhanging the corpora quadrigemina. Below, lies the thickened **medulla oblongata.** The cavity of the IVth ventricle is very much flattened, but by gently pressing the medulla and the cerebellum apart its extent can be clearly seen. Between the anterior end of the cerebellum and the posterior margin

of the corpora quadrigemina, the **valve** of **Vieussens** will be seen as a thin flap of membranous tissue passing into the under side of the cerebellum. From beneath the hinder part of the cerebellum arises the roof of the IVth ventricle, which will be seen to be folded to form a **choroid plexus.** Note that although the cerebellum appears to be solid it is traversed by branching lines, sometimes called the **arbor vitae.** The thickened **medulla oblongata** is continuous with the crura cerebri, and the lower margin shows the outline of the elevation on which the **pons Varolii** lies.

Drawing.—Make a drawing of the section of the brain as you have seen it.

DISSECTION OF THE VTH AND VIITH CRANIAL NERVES

The dissection of the cranial nerves in an animal like the rabbit with a bony skull presents many difficulties, and usually only portions of a few of the nerves can be exposed. If, however, the head is treated in the same way as has been suggested for the removal of the brain, by decalcifying the bones, much more satisfactory dissections can be made. For this purpose, it is essential that the decalcifying process should be as complete as possible, and that the head should have been well hardened by immersion in strong spirit before the dissection is attempted. It sometimes happens that as a result of this treatment the nerves lose their usual white appearance, though if the immersion in spirit has been prolonged, this effect is not so noticeable.

It is advisable that as much of the skin as possible should be removed before the decalcification is effected, but if any portions of skin remain these must be removed, particular care being exercised in the region of the large (masseter) muscle which covers the outside of the lower jaw, because the VIIth nerve lies on the surface of this muscle.

The VIIth Cranial Nerve

Frequently, careful examination of the surface of the masseter muscle will reveal branches of the **VIIth (facial)**

nerve, but if you do not see any traces of the nerve at once, then gently scrape the surface with the edge of a scalpel. As soon as you can distinguish any portion of the nerve beneath the thin connective tissue covering the surface of the muscle, trace it upwards in the direction of the ear. As you approach the region of the ear you will find that the nerve becomes more deep-seated, and superficial muscles have to be divided to expose it. Also in this region the branches covering the surface of the muscle join together so that care must be exercised not to cut any of them. [If there has been any discoloration of the nerves, it is advisable to use a lens as much as possible, as this facilitates the distinguishing of the nerve from the surrounding tissue.]
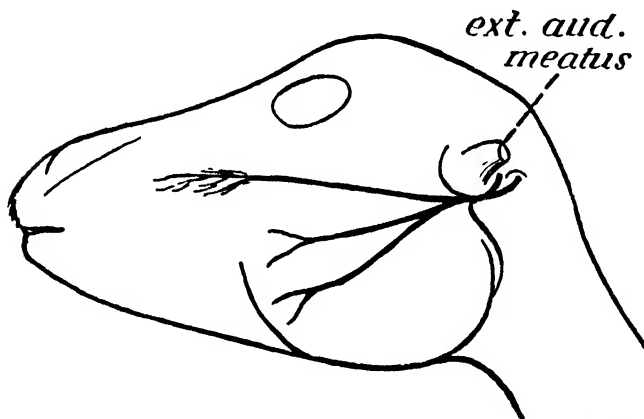
Fig. 77.—Distribution of the VIIth (facial) cranial nerve.

As each branch is made out, trace it to its termination until you have the whole of superficial portion of the nerve clearly exposed. The distribution of the nerve varies in different specimens, but the course of the main branch is from a point just below the ear across the mid-line of the area of the side of the face in the direction of the snout,

where, almost in a direct line vertically below the eye, it fans out into numerous branches. The other branches, usually two in number, though there is much variation, pass to the lower part of the masseter muscle.

Now return to the portion of the nerve where it issues on to the surface just below the ear. At this point, a large branch, passing anterior to the external auditory meatus, is given off to the pinna of the ear. Smaller branches, passing behind the external auditory meatus, and also to the angle of the jaw arise at this point. Trace these branches as far as you can. It will be found that the main root of the nerve passes still more deeply into the muscles, curving around the posterior margin of the lower jaw to reach the cranium from which it issues by the stylomastoid foramen.

Drawing—Within an outline of the head draw in the course of the nerve.

The Vth Cranial Nerve

It is best to commence the dissection of this nerve with the portion which lies in the orbit. First remove the nictitating membrane (third eyelid) by seizing it in a pair of large forceps and pulling it up as far as it will come, releasing it from its attachments to the front of the orbit and cutting through it at the sides. It can then be pulled right out together with the attached Harderian gland, leaving a space at the front of the orbit.

Break down the connective tissue surrounding the eyeball with the back of a scalpel until the eyeball is quite free in the orbit and can be pushed well away from the lower margin. With a scalpel cut through the lateral wall of the buccal cavity (cheek) commencing at the mouth and following the line of the angle of the mouth between the upper and lower jaws, keeping well above the main branch of the VIIth nerve, until the region of the orbit is reached. Turn the head so that its dorsal surface is towards you and put one blade of the scissors into the orbit so that it passes under the anterior part of the

zygomatic arch (see skull) and cut through it. Turn the cut portion up and cut through the arch again at the posterior margin of the orbit. This exposes the muscle-covered ascending portion of the lower jaw. Depress the lower jaw and scrape away the muscles from the ascending ramus until you can see its outline and consequently determine more clearly the position of the remaining spur of the zygomatic arch. With scissors remove this spur and attached muscles so that you can see more clearly into the orbit. Pushing the eyeball up against the roof of the orbit, lift up the membranous floor and break down the connective tissue until the prominent bulge of the maxilla into the anterior part of the orbit can be distinguished. Behind this bulge lies the maxillary branch of the **Vth (trigeminal)** cranial nerve.
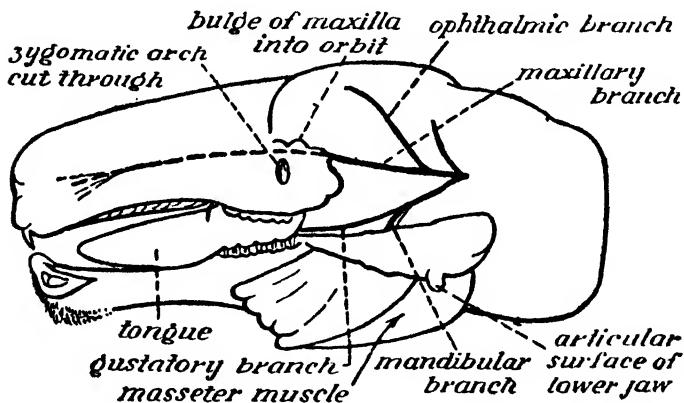
Fig. 78.—Distribution of the Vth (trigeminal) cranial nerve. The zygomatic arch has been cut off and the lower jaw turned outwards and downwards.

Having determined the position of the nerve so as to avoid cutting it, pull the eyeball as far out of the orbit as possible and cut through the optic muscles and nerve,

releasing the eyeball completely, and remove it. Now the **maxillary branch** will be seen lying in the floor of the orbit.

The next operation is to deflect the ascending ramus of the lower jaw to expose the **mandibular branch.** If the muscles covering the ascending ramus have been scraped away as directed above, the articular surface of the ascending ramus can be detected just below the posterior margin of the orbit. Slip the point of the scalpel under it and cut through the muscular attachments on the inner side, continuing the incision backwards over the external auditory meatus, taking care not to cut the root of the VIIth nerve. Then, pressing the ramus outwards away from the cranium, the main branch of the mandibular nerve, often also the smaller **gustatory branch,** will be seen at once on the inner side of the jaw between it and the cranium. Trace the gustatory branch to where it enters the under side of the root of the tongue, and the main branch to where it enters the lower jaw through the dental foramen. [This operation is facilitated if the symphysis of the lower jaw is divided so that the half on which you are working can be pressed downwards, enabling you to get more easily to the inner side of it.]

The dental canal can be slit open, exposing the nerve still further. A smaller branch of this part of the nerve will be seen lying alongside the main branch, and it can be traced to the muscles on the inner side of the jaw. Now trace the mandibular branch backward to where it leaves the cranium by the foramen lacerum medium—actually the anterior part of this foramen, which is separate as the foramen ovale in other mammals.

Now return to the maxillary branch which was seen in the orbit. Keeping the scalpel on its lower side, cut through the bone and trace it along the upper jaw, cutting through the front of the orbit and removing the prominent bulge of the maxilla. You will then find that the nerve fans out into branches in the lateral wall of the nasal chamber. Next trace the nerve back to the cranium, keeping the scalpel on its lower side, for just where it disappears into the cranial cavity through the sphenoidal

fissure (foramen lacerum anterius) the **ophthalmic branch** arises on its upper side and runs along the inner wall of the orbit. Continuing to trace the nerve, cutting through the thin wall of the cranium, you will find that soon it will join up with the mandibular branch exposed previously, and at about the point of junction another nerve arises, passing upwards to the roof of the cranium.

Drawing.—Insert in your previous drawing the course of the Vth cranial nerve.

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